POWER

Volume 57 New York, June 26, 1923 Number 26

Efficient Boiler-Room Help a National Asset

OF THE 600,000,000 tons of coal mined annually in the United States, approximately one-third is burned under stationary boilers.

The results of numerous tests on the boilers of industrial plants show that on an average only 56 per cent of the heat supplied to them is usefully absorbed. The rest is lost by incomplete combustion, heating up excess air, radiation and ashpit losses.

The plants on which this average of 56 per cent is based, are of considerable size and under the management of men who had enough interest in their performance to have them tested. If we include the myriads of small plants in neither the design nor operation of which attention is paid to efficiency, the average efficiency will be considerably lower. This is probably true when referred to the efficiency with which the total amount of coal used in power plants is burned, although the largest consumers, like the big public-service stations, use their fuel to the best effect.

Some of the large stations are getting sustained efficiencies around 80 per cent. One does not have to have a superstation nor enormous boilers to realize such efficiencies. Records are fairly frequent where they are attained on single boilers of moderate capacities under test conditions.

There are numerous industrial plants where the conditions of uniform demand and high load factor are such that continuously high efficiencies are easily attainable.

The essentials are a boiler plant correctly designed for the conditions and interested intelligence in the operating force.

Happily, both of these are obtainable in a degree never before equalled. Better boilers and furnaces and stoking apparatus are to be had. More is known of the processes of combustion and heat absorption. The operation of a boiler plant has become a neat, interesting process inviting a totally different personnel from that of the old-time firing aisle. The chemistry of combustion has found practitioners in the boiler room. The Orsat and CO_2 recorder are doing for the boiler-room manager what the indicator was doing for the engine and the steam engineer a score or two of years ago, and many a practical man has made his mark by concentrating upon this feature of power-plant engineering. The theory is easily accessible to anyone, in literature and correspondence courses, and one who applies it to the boilers about which he works and intelligently observes the results is bound to qualify for better things.

And a corps of men who could bring up the average efficiency of the industrial plant even to 70 per cent would be a national asset and a God-send to industry.

F. R. Low

WABASH RIVER STATION
of the Indiana Electric Corporation

by Frank S. Clark
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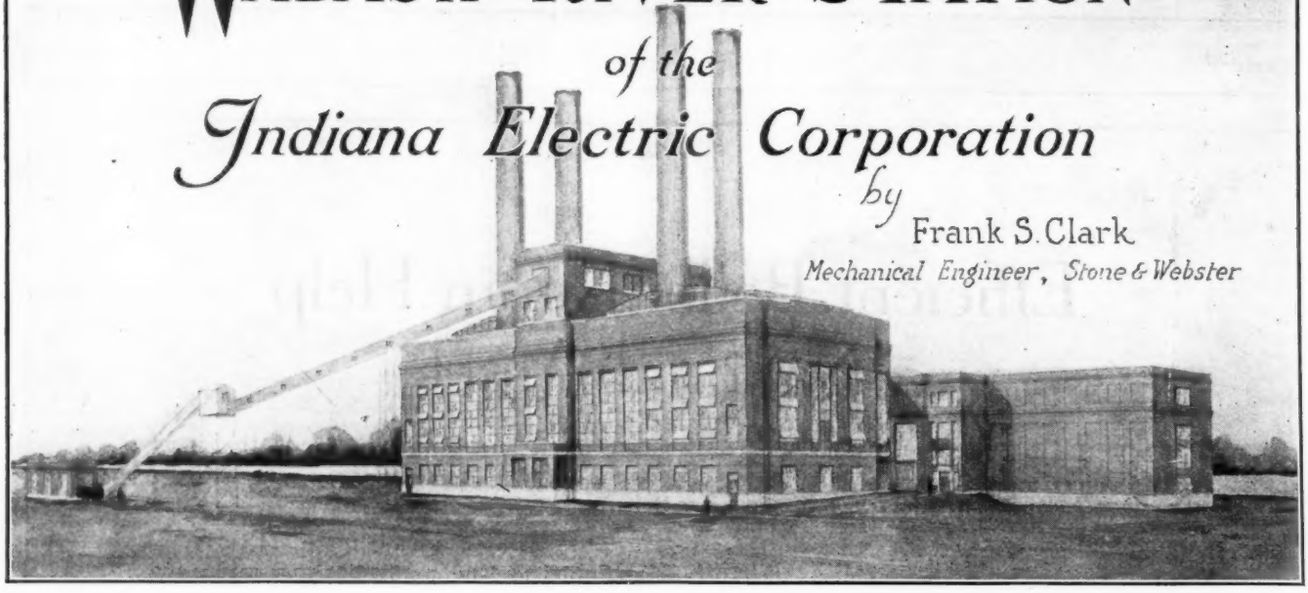


IN THE latter half of 1922 the Central Indiana Power Company was formed to take over the public-utility companies in Indiana, controlled by Kelsey, Brewer & Co. These companies furnish electric light and power to some seventy cities and towns in central, western and northern Indiana. Plans for the consolidation include ultimately the connecting of the various properties by transmission lines and the furnishing of power from the construction of a modern central power station to furnish power to Indianapolis and the properties around Terre Haute and ultimately to serve all the territory covered by the company. A subsidiary company, the Indiana Electric Corporation, was formed to finance the construction of the station.

Stone & Webster, Inc., have been retained to design and construct the station in collaboration with L. B. Andrus, chief engineer of the Kelsey, Brewer interests. Work has been started and the station is expected to begin operation about Jan. 1, 1924. The first section to be built will contain 40,000 kw. installed turbine capacity in two units. The tentative ultimate capacity is 100,000 kw., but this may be increased easily to more than 200,000.

The site selected is on the west bank of the Wabash River about seven miles below Terre Haute, where there is an abundant supply of condensing water and where the company owns sixty-three acres for power-plant purposes, together with over 3,000 acres of coal lands immediately adjacent. These are estimated to contain enough coal to meet the needs of the plant for more than thirty years.

The plant will be built in sections, the present portion having room for two turbo-generators and eight boilers. The design is such that the immediate investment will include but a minimum provision for future installation, and it will permit of taking advantage of any changes in the art in future additions. General features of design and arrangement are shown in Figs. 2 and 3. The turbine room and boiler room are adjacent and parallel with each other, the former being nearer the river. An office bay and switch-house are located at the down-river end of the turbine room. This was done in order to bring the electrical switching equipment as near as possible to the outdoor transformer station, which is at the lower end of the property. The arrangement as worked out gives for this particular case a maximum of accessibility and ease of operation with a minimum of space and of cost of installation.

Building foundations and substructure are of reinforced concrete. As there is a difference of 31 ft. between low water and maximum flood levels, it has been necessary to place the condenser floor 19 ft. below extreme high water and to make the turbine-room substructure in the form of a watertight concrete box, the top being 7 ft. above the level of the highest known flood. Provision against flotation has been taken care of by anchoring the condenser floor to the underlying rock by means of steel rods. The ashroom floor is at the established grade of the property, which is 2 ft. above maximum flood level. The superstructure will have a steel frame with a brick wall, concrete floors and book-tile roof supported on steel purlins. The outside walls will be of selected red brick with limestone trim, and the turbine-room walls will be of ivory-gray faced brick with a salt-glazed brick dado extending 6 ft. 6 in. above the condenser floor and 6 ft. above the turbine-room platform. Red quarry tile will be used for the condenser floor and turbine platform. A railroad siding will extend across one end of the turbine room and a 75-ton, 4-motor traveling crane with 15-ton auxiliary hoist will serve the turbine room and condenser

FIRST section of a 100,000-kw. plant now being constructed close to coal fields. Among the outstanding features are 350 lb. steam pressure, high boilers, stage bleeding, house turbine for emergency only, evaporators and special provision for thirty-one feet rise and fall of river.

floor. There are four floors in the office bay, giving ample space for office and toilet accommodations for the chief engineer and his assistants and the watch engineers. A completely equipped first-aid room and sleeping rooms have been provided for use in emergencies. The top floor of the office bay is devoted to the electrical operating and control rooms and the load dispatcher's room. Windows in the end of turbine room will permit a view of the turbine room from the offices and electrical operating rooms. The office bay is served by a push-button type elevator. A second elevator will be installed in the boiler room.

Supply and Handling of Coal

The chief coal strata underlying the company's property are No. 5 and No. 3 Indiana veins. It is not the company's plan, however, to develop a mine at this present time, as there are numerous working mines in the neighborhood from which a supply of coal can be obtained at a reasonable price. After careful study and tests, forced-draft chain-grate stokers were chosen as the most feasible method of burning the coals that would be available.

Until the mine is developed, coal will be received over a spur track about 1¼ miles long, built to connect the site with the Pennsylvania Railroad. Cars will be dumped into a hopper beneath the tracks and the coal will then pass through a crusher and on a system of belt conveyors into a concrete bunker of about 2,000 tons ultimate capacity, located above the boilers in the center of the ultimate station. One-half of the bunker will be constructed at present. The unloading, crushing and conveying system will be duplicated when the plant is extended. The track hoppers will be housed in a brick building, and provision will be made for the installation of a traveling crane and grab bucket for unloading any gondola cars that may be received. Coal will be delivered from the bunker to the boilers by means of a traveling weigh larry.

The initial boiler installation will consist of four 17,260-sq.ft. cross-drum B. & W. boilers, operating at 350 lb. pressure. Each boiler will have 720 four-inch tubes, twenty feet long in 36 sections, each section containing 20 tubes. The high tube banks were used because the cost of coal did not justify the use of economizers. The bottom two rows of tubes will be arranged as a "slag screen" with ample entrance area for the gases, to prevent adherence of clinkers and slag to the tubes.

The superheaters will have 2,424 sq.ft. surface area each and will be located between the sixth and seventh rows of boiler tubes, counting from the bottoms of the headers. They are designed to give a steam temperature of 650 deg. F. when the boilers are operating at 200 per cent rating.

The boilers will be set with their headers at the uptake end, 21 ft. 7 in. above the floor, giving a furnace volume of about 4,014 cu.ft., or 0.23 cu.ft. per rated square foot of boiler-heating surface. There will be two stokers per boiler, each of 202 sq.ft. grate surface, or 404 sq.ft. per boiler. Arches will be placed over the front and rear of each stoker, the front or ignition arch being 8 ft. 6 in. long. The rear arch will extend from the back wall to a point about midway over the rear combustion zone. This arch is designed to throw the gases containing excess air back toward the front of the boiler, where they will mix with and complete the combustion of the richer gases distilled from the front portion of the stoker. It will also decrease ashpit losses by preventing unconsumed carbon being blown from the rear portions of the grate into the ashpit. The arch

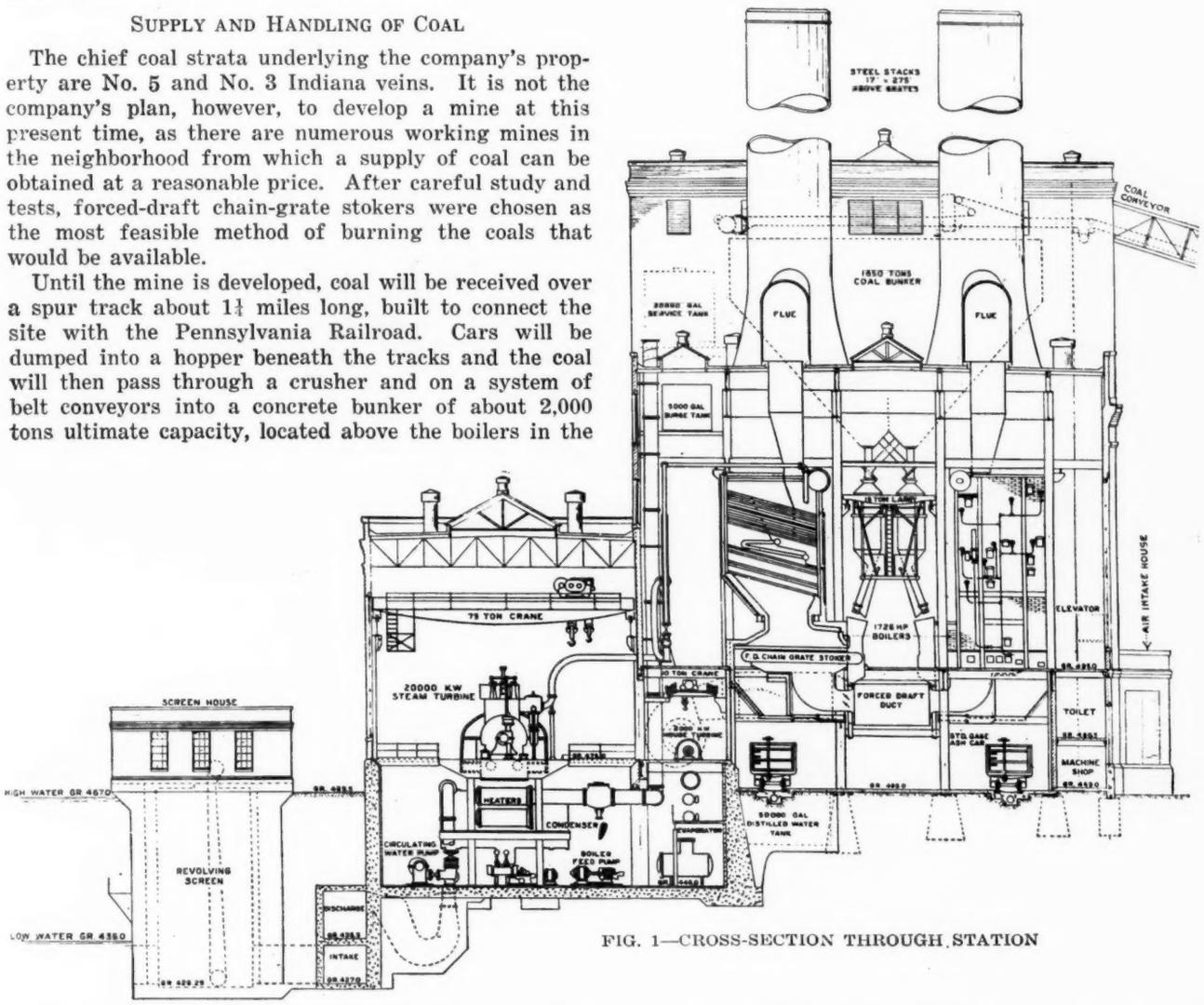


FIG. 1—CROSS-SECTION THROUGH STATION

is given a decided pitch in order to reflect the heat back onto the rear portions of the grate and sustain temperature sufficient to complete the combustion of the fuel. Furnace walls will be of solid firebrick, 26 in. thick. The side walls immediately above the grate will be protected by two 4-in. tubes connected directly into the boiler circulation. The setting will stand within a structural buckstay framework designed to support and restrain the walls, but to allow sufficient freedom for expansion. Two rows of bonding tile fastened to bulb angles forming part of the buckstay system, will tie the walls at two points in their height. A system of soot-blowing elements will be installed among the tubes.

Ash hoppers sufficient for a day's accumulation of ashes will be installed with four air-operated gates for each hopper, and the ashes will be dumped directly into railroad cars run underneath the hoppers.

Forced draft will be supplied by motor-driven fans discharging into a central duct under the boiler-room floor. Each fan will furnish sufficient air for four boilers at 225 per cent rating. One stack with outside flues will serve four boilers. This will be of steel superimposed on the building steelwork. It will be 17 ft. in diameter inside the brick lining and extend 275 ft. above the grates.

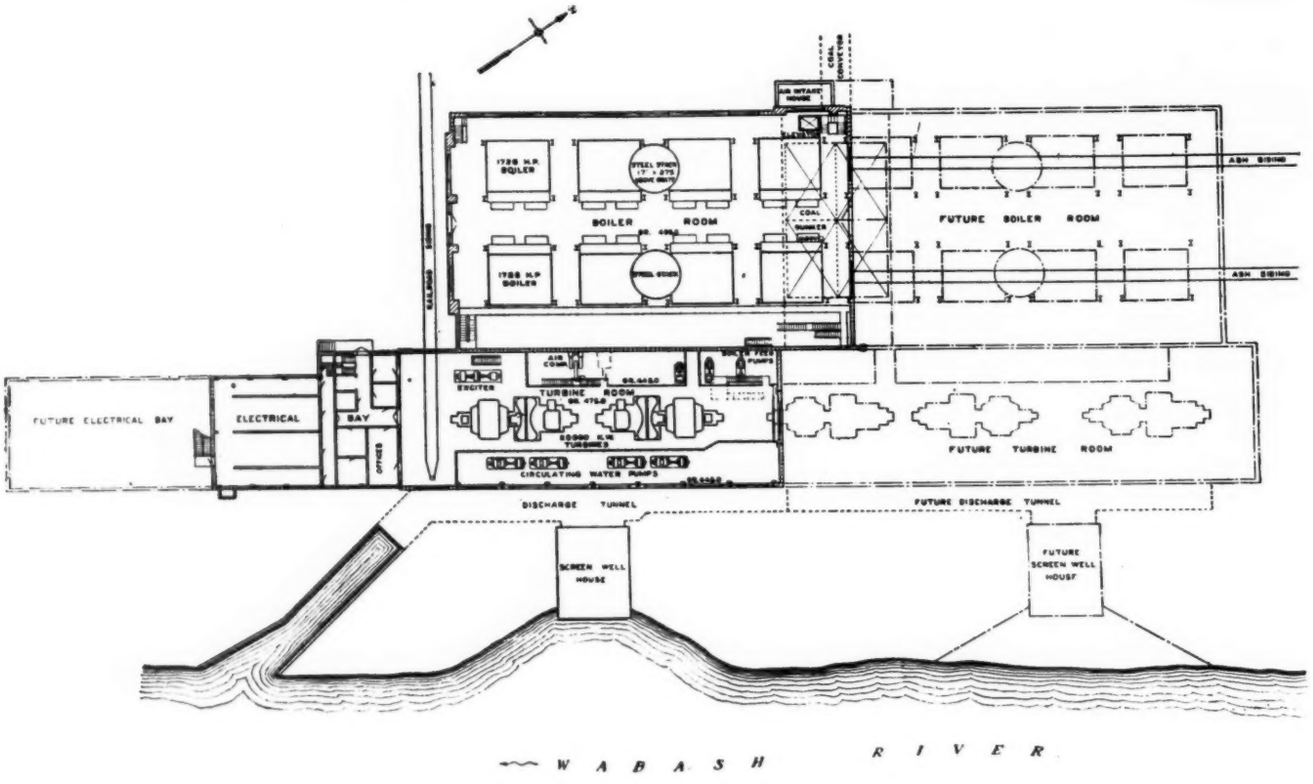


FIG. 2—PLAN SHOWING PRESENT AND FUTURE SECTIONS

Main Generating Units and Heat Balance

The turbine room of the present section under construction will accommodate two 20,000-kw., single cylinder turbo-generators. These are single-flow Westinghouse units, embodying all the recent changes, including the new Bauman type blading and stream-line exhaust casing described in *Power*, Feb. 7, 1922, and Jan. 2, 1923. The units will be arranged for bleeding steam for feed heating from the third and the fourth blade rings. About 25,400 lb. per hour will be bled at full load, this being sufficient to heat the condensate to 208 deg. F., at the exit from the second heater. Each unit will have a 125-kw., 250-volt direct-connected exciter. Each turbine will exhaust into a 40,000-sq.ft. surface condenser of the two-pass, two-compartment type, enabling the turbine to be kept in operation while the tubes are being cleaned. Two circulating water pumps and two hotwell pumps will be installed with each condenser. There will be three sets of air ejectors, one set per condenser and one as a spare common to the two.

House Turbine for Emergency Use Only

The house turbo-generator will be of 2,000 kw. capacity and will be of the non-condensing type intended for service only in an emergency that would cause a failure of the auxiliary supply from the main unit. The generator will normally run as a motor, the turbine being connected to the condenser of the main unit through a small pipe in order to maintain a vacuum in the turbine casing. This will enable the wheels to run in a vacuum and keep cool without the necessity of bleeding any quantity of steam into the casing. In case of failure of the electrical power supply, the steam will automatically be admitted to the turbine and the unit will immediately pick up the auxiliary load. As this is purely an emergency condition, the steam from the unit will exhaust to the atmosphere. As the water available for makeup is "hard," evaporators are necessary. One set of 20,000 lb. per hour capacity will be installed. This will be of the two-effect high-heat-level type. The evaporator condenser will be of the closed type, the discharge from the boiler-feed pumps being passed through it on the way to the boilers. This will raise the temperature of the feed to about 240 deg. The evaporator will furnish makeup for half the ultimate station capacity. A concrete storage tank of 50,000 gal. capac-

ity will be constructed under the ashroom floor, to serve as a reservoir for the makeup water. Provision is made for deaërator equipment, but none will be installed at present.

All auxiliaries will be electrically driven with the exception of one 500-gal. per min. feed pump, one fire pump and the spare 150-kw. exciter, which will be a duplex unit.

Two bleeder heaters are provided with each turbine. Condensate will pass through the oil coolers, air ejector, condensers and bleeder heaters to a surge tank in the boiler room about 95 ft. above the feed pumps, which are on the condenser floor. An auxiliary closed heater is provided for use when either the steam-driven feed pump or exciter is running and exhaust steam is available for feed heating. At such times one of the bleeder heaters may be shut off or its steam supply restricted to give a feed temperature to the pumps of about 210 deg. From the feed pumps the feed water passes through a closed high-pressure heater, which serves as the evaporator heater and then into the boiler-feed mains. There will be two 4-in. feed connections to each boiler with a feed-water regulator and a venturi meter in each connection.

A closed system of generator air cooling will be installed, using spray-type coolers of 65,000 c.f.m. capacity for each generator.

Handling the Circulating Water

The circulating-water tunnels are immediately outside the turbine-room wall. There will be two screen wells for the ultimate plant, one being constructed with the first section of the station. As the Wabash River at flood tide carries a great quantity of trash, leaves and farm refuse, special care is taken to prevent any great quantity being drawn into the tunnels. Traveling screens will be installed, and in addition there will be racks and emergency screens at the water inlets. Circulating-water connections between the pumps and condensers will be short and direct. Valves will be motor operated. As an aid in decreasing the pumping head through the circulating system, the discharge connections leading from the condenser are designed as draft tubes.

All piping has been laid out with a view toward a maximum of simplicity without endangering continuity of operation. The high-pressure steam system is simple and direct. The number of flanged joints has been reduced to a minimum by the use of telescopic-type line welds and interlocking-type welded nozzle outlets. Where joints are used, they are of the "Sargol" type. A 10-in. angle type, direct-current, motor-operated nonreturn valve, equipped with remote control, will be installed at each superheater outlet. The sectionalizing valves in the 16-in. main header and the valves in each turbine lead will also be motor operated and remote controlled, using alternating current. Each motor-operated steam valve will have two control stations, one at the valve and the other in the switchboard operator's room for emergency use.

Boiler-feed piping will be extra-heavy steel with cast or rolled steel hydraulic-type flanges (800 lb. standard). Valves will be bronze mounted and will have cast-steel bodies.

Some Electrical Features

There will be two three-phase, 13,200-volt buses, with two selector oil circuit breakers per circuit. Static dischargers will be provided on each bus. At the present time no protective reactors will be installed, but the arrangement is such that an extension to the building can be added in the future to house such equipment.

Cables from the generators to the circuit breakers will be carried in ducts temporarily and ultimately will be supported on insulators in open galleries. Differential relay protection will be installed for each generator.

Ultimately, there will be two 2,500-kva. banks of station power transformers, and in case of failure of a transformer or any interruption to the supply of energy

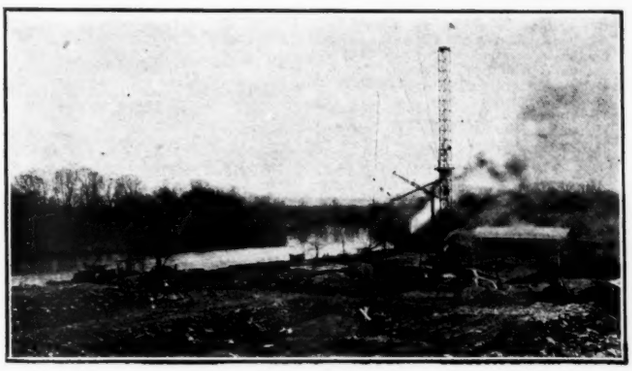


FIG. 3—RECENT CONSTRUCTION PHOTOGRAPH SHOWING FOUNDATIONS

to the 2,300-volt station bus, the house turbine generator will automatically be brought into service for relay purposes.

With the exceptions previously noted, all station auxiliaries are motor driven and all the larger units will be operated at 2,300 volts and the smaller motors at 440 volts three-phase. The service feeders for these motors are so grouped that there will always be two feeders for any important service.

Two 450-kva. banks of transformers will be used to supply power from the 2,300- to the 440-volt buses.

A signal system is provided, operated from direct current and arranged with one transmitting equipment in the switchboard control room and a receiver at each generating unit. These signal devices are similar to the control standards used in ship pilot houses. Load bulletins are provided in both the turbine room and the boiler room, operated from the switchboard control room and so constructed that the load on the station will always be automatically indicated through a connection to the station totalizing wattmeter. Means also are provided on the load bulletin indicators so that advance notice can be given of expected load changes.

Annunciators will be placed in the turbine room and in the switchboard control room, which will indicate automatically any interruptions on the auxiliary equipment, automatic opening of oil circuit breakers, operation of temperature alarms or other similar occurrences that require immediate attention of the operators.

Particular study has been given to the question of lighting, and in addition to the alternating-current system, certain outlets are connected to the storage battery with automatic throwover devices so that in case of failure of the alternating-current system there will be sufficient lights connected to the battery to operate the station.

An automatic intercommunicating telephone system and watchman's clock system will be provided in addition to the usual connections to the Bell telephone system.

DATA ON PRINCIPAL EQUIPMENT IN THE WABASH RIVER STATION OF THE INDIANA ELECTRIC CORPORATION

GENERAL

Location of plant	Macksville, Indiana
Character of load	Supply light and power to various communities over transmission lines
Capacity, ultimate	100,000 kw.
Capacity, present	2—20,000-kw. units
Boilers, ult. (17,260 sq.ft. each)	16
Boilers, immediate	4
Turbine room, ult. (5 units)	57x347 ft.
Turbine room, immediate (2 units)	57x153 ft.
Offices and electrical operating room (4 floors each)	32 ft.x56 ft. 9 in.
Switchhouse, ultimate	46x129 ft.
Switchhouse, present	46x45 ft.
Boiler room, ultimate	101 ft.x316 ft. 6 in.
Boiler room, present	101x162 ft.
Sq.ft. station area per kilowatt installed (ultimate)	0.59
Distance, condenser floor (gr. 448) to turbine platform (Gr. 475)	27 ft.
Distance, turbine platform (gr. 475) to crane rail	30 ft.
Distance, turbine platform (gr. 475) to bottom chord roof truss	42 ft.
Distance, ashroom floor (gr. 469) to boiler-room floor (gr. 495)	26 ft.

BOILERS AND SUPERHEATERS

Make of boilers	Babcock & Wilcox
Type	Cross-drum, water-tube
Number, present	4
Number, ultimate	16
Boiler pressure, gage	350 lb.
Water-heating surface, each	17,260 sq.ft.
Diameter of drum	54 in.
Size of tubes	4 in. No. 7 B.w.g.
Length of tubes	20 ft.
Number of sections	36
Number of tubes per section	20
Width of furnace	21 ft. 4 in.
Grate area, projected per boiler	404 sq.ft.
Ratio water-heating surface to grate area	42.7:1
Water heating surface per kilowatt installed (ultimate)	2.76:1
Heating surface per sq.ft. boiler room floor area (ultimate)	8.64
Furnace volume	4,014 cu.ft.
Ratio furnace volume to water-heating surface	0.23:1
Ratio furnace volume to projected grate area	9.93:1
Make of superheaters	Babcock & Wilcox
Type of superheater	Convection
Location of superheaters	Between sixth and seventh rows of tubes
Superheating surface per boiler	2,424 sq.ft.
Ratio superheating to boiler-heating surface	14:100
Steam temperature at 225 per cent rating	650 deg. F.
Corresponding superheat	215 deg. F.
Steam outlet from superheater	One, 10 in. dia.

STOKERS

Make of stoker	Babcock & Wilcox
Type	Forced-draft chain-grate
Number per boiler	2
Effective length, each stoker	21 ft. 3 in.
Width of each stoker	9 ft. 6 in.
Grate area of each stoker	202 sq.ft.
Chain speed per hour at max. rating	44.0 ft.
Coal burned per sq.ft. of grate at max. rating	41.2 lb.
Each stoker driven by	3 hp. induction motor
Make of motor	General Electric Co.
Stoker speed control by	Reeves variable speed transmission
Stoker arches by	American Arch Co.
Front arch, length	9 ft. 0 in.
Rear arch, length	7 ft. 0 in.
Side-wall protection	7 ft. 0 in.

Stoker Performance

Boiler Rating, Per Cent	Comb. Eff. Boiler & Stoker, Per Cent	Coal per Sq.Ft. per Hr. Pounds	CO_2 in Flue Gas, Per Cent	Combustible in Ash, Per Cent
100	77.2	16.4	12.0	10
200	78.0	32.4	13.0	12
250	76.5	41.2	13.0	15

Coal Burned, No. 5 Vein Indiana

Ash	14.40 per cent
Moisture	8.50 per cent
Volatile	38.30 per cent
Fixed carbon	38.80 per cent
Calorific value (as fired)	11,160 B.t.u.
Sulphur	3.62 per cent
Fusing Temperature of Ash	1,900-2,000 deg. F.

CHIMNEYS

Type	Self-supporting steel
Made by	Chicago Bridge & Iron Co.
Number, immediate	1
Number, ultimate	4
Height above boiler-room floor	275 ft.
Diameter at top, inside of lining	17 ft.
Lining	Radial brick
Furnished by	American Chimney Corp.
Chimney supported on	Building steel framework

COAL HANDLING

Type	Belt conveyor
Furnished by	Link-Belt Co.
Capacity, immediate	100 tons per hour
Capacity, ultimate	200 tons per hour
Width of belt	24 in.
Speed of belt at rated capacity	300 ft. per min.
Crusher, type	30 in. x 36 in. two roll
Crusher make	Link-Belt
Crusher, capacity	100 tons per hour
System will be duplicated for ultimate capacity.	
Overhead bunker, type	Concrete
Location—Crosswise of boiler room at center of ultimate station	
Capacity, immediate	1,000 tons
Capacity, ultimate	2,000 tons
Coal distributed to boilers by	15-ton weigh larry
Larry furnished by	Stephens-Adamson Mfg.Co.
Yard—coal storage	30,000 tons
Method of reclaiming from storage	Locomotive crane and railroad cars
Locomotive crane, make	Link-Belt Co.
Yard locomotive, saddle tank type	American Locomotive Co.

TURBO-GENERATORS

Main Units

Manufacturer	Westinghouse Elec. & Mfg. Co.	
Type	Combined impulse and reaction	
Number, immediate	2—20,000 kw. each	
Number, ultimate	5—20,000 kw. each	
Units arranged for bleeding at	2 points	
Pressure at bleed points at 20,000 kw.	5.6 lb. and 16.4 lb. abs.	
Capacity per sq.ft. Turbine-room floor area (ultimate plant)	5.06 kw.	
R.p.m.	1,800	
Weight per kilowatt	38.2 lb.	
Pressure at throttle	300 lb.	
Temperature at throttle	650 deg. F.	
Steam to throttle at 300 lb. 650 deg. F. and 29 in. vac.	16,000 kw.	20,000 kw.
With no bleeding	10.08 lb.	10.21 lb. per kw.-hr.
With bleeding	10.40 lb.	10.65 lb. per kw.-hr.
Steam to condenser, with bleeding	9.24 lb.	9.38 lb. per kw.-hr.
Type of generator	3-phase, 60-cycles, 13,200 volts	
Ventilating air for generators	65,000 cu.ft. per min.	
Drive for main exciters	Direct connected to main unit	
Size of main exciters	125 kw.	
Excitation voltage	250	

Emergency House Generator

Manufacturer	Westinghouse Elec. & Mfg. Co.
Type	Noncondensing combined impulse and reaction
Capacity	2,000 kw.
Number, immediate	1
Number, ultimate	2
R.p.m.	3,600

Spare Exciter

Type	Combined turbine and motor drive
Make	Terry Steam Turbine Co.
Capacity	150 kw.
R.p.m.	1,200
Voltage	250

CONDENSERS

Type	Surface, two-compartment
Manufacturer	Westinghouse Elec. & Mfg. Co.
Tube surface, each	40,000 sq.ft.
Sq.ft. tube surface per kw.-main unit	2.0
Support	Springs
Performance	29 in. vac. with max. load on turbine when bleeding steam and with 40,000 gal. per min. circ. water at 60 deg., 28.73 in. vac. with 70 deg. circ. water

Circulating Water Pumps

Number	Two per condenser
Capacity, one pump running	25,000 g.p.m.
Capacity, two pumps running	40,000 g.p.m.
Drive	Slip-ring motor
Capacity, gal. per min. per kw. main unit	2

Condensate Pumps

Number	Two per condenser
Type	Two-stage
Capacity, each	315,000 lb. per hour
Drive	Squirrel cage motor

Air Eductors

Number	One set per condenser with one common spare set
Each set consists of	Two, 2-stage ejectors with surface type intercooler and after condenser

SCREEN WELLS AND INTAKE TUNNELS

Screen wells, number, immediate	1
Screen wells, number, ultimate	2
Type of screens	Travelling
Make	Link-Belt Co.
Number per screen well	2
Width, each screen	8 ft. 6 in.
Travel	15 ft. per min.

MISCELLANEOUS EQUIPMENT

Forced Draft Fans

Number, immediate	2
Number, ultimate	5
Make	American Blower Co.
Type	Double-inlet, full housed angular top discharge
Capacity	225,000 c.f.m.
Discharge pressure, inches of water	2 in. at 305 r.p.m., 5 in. at 514 r.p.m.
Driven by	200 hp., 16-pole G.E. motor

Boiler Feed Pumps

Number, immediate	3
Type	Jeanesville, double-suction, centrifugal
Capacity	Two—1,000 gal. per min. One—500 gal. per min.
Discharge head	425 lb. per sq.in.
Number of stages	4
Make	Worthington Pump & Machinery Corp.

DATA ON PRINCIPAL EQUIPMENT IN THE WABASH RIVER STATION OF THE INDIANA ELECTRIC CORPORATION (*Continued*)

MISCELLANEOUS EQUIPMENT—Continued

1,000 gal. per min. pumps driven by	350 hp. phase-wound slip-ring, variable-speed Westinghouse induction motor, 1,800 r.p.m.
500 gal. per min. pump, driven by	Westinghouse non-condensing turbine, 2,200 r.p.m.
Evaporator	
Type	Two-effect, high heat level
Make	The Griscom-Russell Co.
Capacity	20,000 lb. per hour
Bleeder Heaters	
Number	Two for each 2,000-kw. turbine.
Type	Closed
Make	Westinghouse Elec. & Mfg. Co.
Tube surface—primary	925 sq.ft.
secondary	900 sq.ft.
Generator Air Coolers	
Type	Water sprays, closed recirculating system
Capacity for each 20,000-kw. unit	65,000 cu.ft. air per min.
Make	Spray Engineering Co.
Supply Pumps	
Two 500 gal. per min., motor driven	Morris Machine Works / Westinghouse Elec. & Mfg. Co.
Discharge Pumps	
Two 500 gal. per min., vertical motor driven	Morris Machine Works / Westinghouse Elec. & Mfg. Co.
Service Pumps	
Two 1,500 gal. per min., motor driven	Worthington Pump & Mchy. Corp / Westinghouse Elec. & Mfg. Co.
Fire Pump	
One 1,500 gal. per min., turbine driven	Worthington Pump & Mchy. Corp / Westinghouse Elec. & Mfg. Co.
Clean Drip Pumps	
Two 300 gal. per min., vertical motor driven	Morris Machine Works / Westinghouse Electric & Mfg. Co.
Dirty Drip Pumps	
Two 100 gal. per min., vertical motor driven	Morris Machine Works / Westinghouse Elec. & Mfg. Co.
Water Filters	
Three 500 gal. per min. each. Sand pressure type, made by	Roberts Filter Mfg. Co.
Screen Well Pumps	
Two 900 gal. per min., vertical motor driven	Morris Machine Works / Westinghouse Elec. & Mfg. Co.
Turbine-Room Cranes	
One 75-ton capacity, 57 ft. span, 4-motor, made by	Northern Engineering Works
One 10-ton capacity, 10 ft. span, 1-motor, made by	Northern Engineering Works
Oil Filtering Systems	
For each of main turbo-generators, partial filtration, continuous bypass system	S. F. Bowser & Co.
For general service, one centrifugal oil filter	DeLaval Separator Co.
Air Compressor	
One 380 cu.ft. per min., motor driven	Ingersoll-Rand Co. / Westinghouse Elec. & Mfg. Co.

MISCELLANEOUS EQUIPMENT AND MATERIALS

Eight 4-in. "Stets" type B, feed-water regulators, made by	The Williams Gauge Co.
Eight 4-in. venturi meters for boiler feed, furnished by	Simplex Valve & Meter Co.
Two 10-in. venturi meters for boiler feed, furnished by	Simplex Valve & Meter Co.
Safety valves	Consolidated Safety Valve Co.
Blow-off valves	B. & W. Co.
Blow-off cocks	Everlasting Valve Co.
Fire brick and clay, furnished by	A. P. Green Firebrick Co.
Arches, furnished by	American Arch Co.
Bonding tile, furnished by	Babcock & Wilcox Co.
Smoke flue and forced-draft ducts	Terre Haute Blr. Wks. Co.
Boiler room and office bay elevators	Otis Elevator Co.
Cast-iron ash hoppers and ash gates	Allen-Sherman-Hoff Co.
Muntz metal condenser tubes	Bridgeport Brass Co.
Circulating-water valves	Chapman Valve Mfg. Co.
Rubber expansion joints	U. S. Rubber Co.
Copper expansion joints	E. B. Badger & Sons Co.
Special circ. water castings	The Lumsden & Van Stone Co.
High-pres. steam pipe and fittings	Pittsburgh Valve, Fdry. & Constr. Co.
High-pres. steam gate valves	Crane Co.
Boiler non-return valves	Pittsburgh Valve, Fdry. & Constr. Co.
Sargol welded joints, under license from	Pittsburgh Piping & Equip. Co.
Low-pressure steam and water-gate valves	Chapman Valve Mfg. Co.
Atmospheric relief valves	Atwood & Morrill Co.
Cooling equip. for drinking water	The Automatic Refrigerating Co.
Surge and storage tanks	Terre Haute Blr. Wks. Co.
High-pressure water valves	Pittsburgh V. F. & C. Co.
Operating and control mechanism for motor-operated valves	Payne Dean, Ltd.
Structural steel	McClintic-Marshall Co.
Steel sash and sash operators	Truscon Steel Co.
Louvres & ventilators	E. Van Noorden Co.
Skylights	G. Drouve Co.
Station designed and constructed by	Stone & Webster, Inc.

Accurate Roots with a Slide Rule

By a simple calculation in long-hand arithmetic an approximate square root as read from a slide rule can be made correct to five places of figures. The rule is this:

Divide the given number by its approximate square root as obtained from the slide rule. The quotient will be another approximate square root differing but little from the first. Average the two approximate roots to get a square root correct to five places of figures.

As an example, suppose it is desired to find the square root of 51.46 correctly to five places of figures. The calculations are as follows:

Approximate root by slide rule = 7.16;
51.46 ÷ 7.16 = 7.18716;
Square root = average of 7.16 and 7.18716 = 7.17358, say 7.1736;
Check: $7.1736^2 = 51.4605$.

The principle back of this method is easily understood. By proceeding in the manner shown, we obtain two numbers of almost the same size which when multiplied together give the original number. If both numbers happen to be the same, they are obviously both equal to the exact square root. If one number is a little greater than the true square root, the other must be smaller by practically the same amount because the product remains unchanged. Averaging the high and low values gives a second approximation, which is accurate to 1 part in 90,000 if the original approximate root is accurate to 1 part in 300, a degree of accuracy easily obtained with a slide rule.

A similar scheme can be worked for cube root. If three numbers can be found, all practically equal, that will give the original number when multiplied together, the average of the three may be taken as the correct cube root. This principle is applied in the following rule:

Find the approximate cube root with the slide rule. Square this and divide the square into the original number. Add the quotient to twice the original approximate cube root and divide the sum by three to get a cube root correct to four or five places of figures.

For example, take the problem $\sqrt[3]{297.63} = ?$ The approximate cube root from the slide rule is 6.66. Squaring this gives 44.3556, which goes 6.71009 times into 297.63. We then see that $6.66 \times 6.66 \times 6.71009$ equals 297.63, so the more exact cube root should be the average of 6.66, 6.66 and 6.71009, which is 6.6767. Cubing this as a check gives 297.636.

The distinction between a deactivator and a deaërator is that the former removes oxygen alone, while the latter removes all dissolved gases. The methods used are fundamentally different in that deactivation is a chemical process in which the dissolved oxygen uses itself up in the act of corroding a mass of finely divided iron or steel, while deaëration is entirely a physical process depending chiefly upon a reduction of the partial pressure of the gas over the water. The various kinds of deaërating apparatus differ from each other principally in the exact method of reducing the partial pressure and in the provision made for disentangling the bubbles of entrained air.

TELLS how the Lincoln type of synchronism indicator operates, how it is constructed and points to be kept in mind in connection with its use and maintenance.

Getting Acquainted with the Synchronism Indicator

BY RALPH BROWN*

WHEN two alternating-current generators are connected in parallel, they must have the same voltage and polarity, as is the case with two direct-current machines. But when the polarity of direct-current machines is once established, it does not change, so that the polarity and voltage can be checked on the voltmeter. With alternating-current generators the polarity is continuously changing, consequently when two machines are operating separately any relation may exist between their polarities. Before the switch can be closed connecting two machines in parallel, they will have to be operating at the same frequency and their voltages will have to pass through their corresponding positive and negative values at the same instant. That is, when the voltage is in one direction on one machine, it must be in the same direction on the other machine at the same instant and of the same value. Under such a condition the machines are in synchronism. Although lamps or a voltmeter may be used to indicate synchronism, in most all modern plants a synchronism indicator is used.

Fig. 1 shows the essential parts of the Lincoln-type synchronism indicator, or synchroscope. The two armature coils R and X consist of a number of turns of small

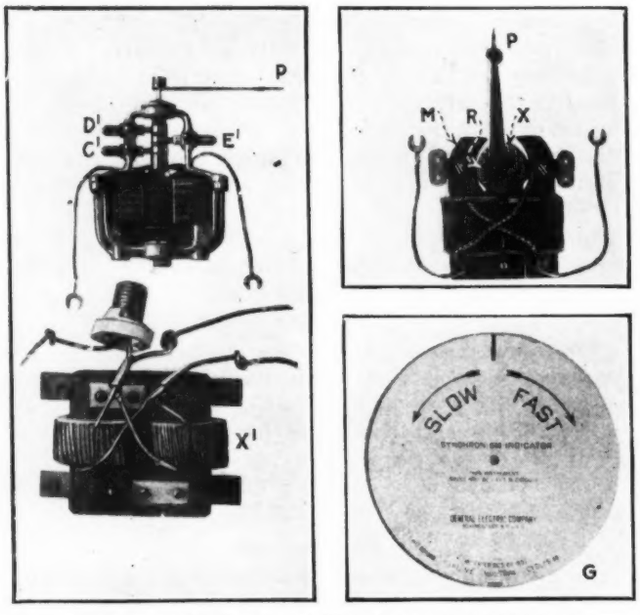


FIG. 1—PARTS OF A LINCOLN SYNCHROSCOPE

copper wire wound on the surface of an insulated iron core at nearly right angles to each other. In order that the indications of this instrument shall be correct, coils R and X must produce magnetic fields differing in phase by nearly 90 deg. Two of the armature coil leads connect together as in Fig. 2 and connect to collector ring E', which is insulated from the shaft with fiber, and each of the remaining leads connects to adjacent collector rings C' and D'. Current is conducted to the collector rings through round carbon brushes, Fig. 1. The brush-holders are inserted in fiber bushings in the brass bracket which supports the armature

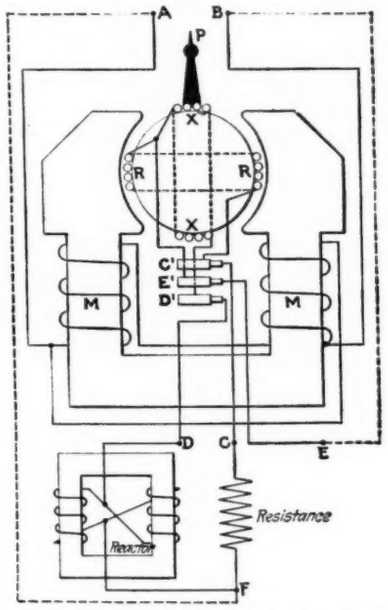


FIG. 2—DIAGRAM OF SYNCHROSCOPE CONNECTIONS

shaft in small ball bearings. One end of the shaft is threaded, and the pointer P is locked thereto by means of a machine screw inserted in its split hub.

The field magnet M is made of laminated iron, and the armature air gap is unusually long. Two field coils are connected in parallel and excited with current from the generator bus or the running machine. These coils have a high inductance, so that the current lags nearly 90 deg. behind the applied voltage.

What may be called the motor structure is inclosed within a cast-iron case, through the back of which pass five connecting studs marked A, B, C, D and E, Fig. 2. The back of the dial G, over which the pointer moves, is made of sheet iron, hence the instrument is shielded from stray magnetic fields. The dial is protected by a glass cover, and the design of the synchronism indicator, Fig. 1, is such that with proper connections, the pointer rotates in a counterclockwise direction "Slow" when the frequency of the incoming generator is less than that of the bus, and in a clockwise direction "Fast" when the incoming generator frequency exceeds the bus frequency. The revolutions of the pointer are equal to the difference between the frequencies.

Since coil X, Fig. 2, is connected in series with a reactance that causes its current to lag approximately 90 deg. behind the voltage as in the field coils, then with armature coil X connected to the running machine and the field coils M connected to the incoming machine,

*Great Western Power Company.

when the two are in synchronism, coil *X*, and with it the pointer, will take a vertical position. This is caused by the lines of force of coil *X* aligning themselves with those from the field poles. In other words the *N* field pole will attract the *S* pole of coil *X* and the *S* field pole will attract the *N* pole of the coil. When any condition exists other than synchronism the relation between the current in the two armature coils and the field poles is such as to cause rotation of the armature, as explained in the foregoing.

Suppose that the field coils *M*, Fig. 2, are excited with 60-cycle current and that the frequency of the current applied to coils *X* and *R* is 59 cycles. The difference between the frequencies, one cycle, will cause the armature to revolve at a speed of one revolution per second in a counterclockwise direction. With the field coils still excited with 60-cycle current, assume that the frequency of the current applied to the armature is increased to 61 cycles. The difference between the frequencies is now, as before, one cycle, but the interaction between the field and armature fluxes causes the armature to revolve at a speed of one revolution per second in a clockwise direction. Since, with voltages of unequal frequencies applied to the field and armature circuits the revolutions made by the armature are equal to the difference between the frequencies, the device shown in Figs. 1 and 2 operates as a bipolar synchronous motor. When the source from which the field poles are excited and the source to which the armature is connected are in synchronism—that is, pass through their positive and negative value at corresponding periods—the pointer will take a vertical position.

Referring to Fig. 2, it will be seen that the terminals marked *A* and *B* connect to the field windings. The terminals *C*, *D* and *E* connect to the collector rings, and the lead *F* is the common connection for the resistance and reactance used to cause the current in coil *X* to lag the current in coil *R* nearly 90 deg. The reactance consists of two coils connected in parallel, assembled on a laminated iron core, Fig. 1*X'* and inclosed in a metal case. A 55-watt 110-volt lamp forms the resistor used in connection with the synchronism indicator designed for 110-volt service, this lamp being mounted on the reactance box. The position of the pointer, the end of which should be over the mark on the dial when the current in the field circuit is in synchronism with that in the armature circuit, can be checked by connecting *B* to *E* and *A* to *F*, as indicated by the dotted lines in Fig. 2, and applying rated voltage at normal frequency to terminals *A* and *B*.

This type of synchronism indicator produces considerable torque, even with a material difference existing between the bus and generator voltages. The only parts subject to appreciable wear are the collector rings and brushes, and in order to avoid this wear the instruments should never be connected when circuit conditions are such that the armature will oscillate or revolve rapidly. Poor brush contact will, under certain conditions, result in incorrect indications, hence the brushes and collector rings should be inspected periodically and given any necessary attention. Access to the interior of the instrument can be had by removing the glass cover, pointer and dial; and after the pointer is attached to the shaft, its position must be carefully checked by using connections equivalent to those shown in Fig. 2. The duty imposed on the bearings is light, yet they should occasionally be inspected and a small amount of vaseline applied to the steel balls and shaft. The collector rings and brushes must be kept free of lubricants. Since the armature coils are wound with rather small wire, the armature will attain an objectionably high temperature if left in circuit 15 or 20 min., hence the reason why the instrument should not be connected except while synchronizing.

Synchronizing plugs and receptacles or their equivalent are used to connect the synchronism indicator to the circuits to be synchronized, the requirement being that the generator, or "incoming machine" potential, shall be applied to wire *F* and terminal *E*, Fig. 2, and that the bus, or "running machine" potential, be applied to terminals *A* and *B*. Potential must be obtained from the same phase in each case. Synchronizing lamps are generally placed near the instrument, their purpose being to check for synchronism when the difference between the bus and generator frequencies is so great that the pointer will not give an indication and as a check on the operation of the synchronism indicator at other times. Before synchronizing, the precaution should be taken to cause the pointer to make one or two revolutions, by changing the frequency of the generator if necessary, and checking the movement of the pointer with the indications of the synchronizing lamps. If the secondaries of the potential transformers which energize the synchronism indicator are grounded, this being the common practice, the synchronizing lamps will be dark at synchronism, but if the secondaries are not grounded, the synchronizing lamps may be connected so as to be either dark or bright at synchronism.

Quick and Ready Methods of Aligning an Engine

By Thos. Airey

One method employed to discover if an engine is out of alignment is that of stretching a line through the cylinder and stuffing box. The line is passed through a small hole in the end of a piece of iron plate that is secured to the face end of the cylinder by one of the stud bolts. It is then passed through the bore of the stuffing box and over a supporting bracket fixed at the main-bearing end of the engine, a weight being attached at the end to keep it tight. Although the method is the most accurate one, it entails a lot of time, and as time is of great importance in the power house, some simpler method is often to be preferred.

An engine fitted with a bored guide seldom gets out of alignment with the cylinder because the crosshead guides are bored square with the end face which meets the cylinder. Yet as time goes on, the stuffing-box neck ring and gland become worn, gradually letting the piston fall to the bottom of the cylinder. Thus misalignment is set up between the piston and the guides.

A method of aligning the guide with the cylinder is by removing the packing from the stuffing box. The crosshead shoe is then adjusted until the gland enters the stuffing box freely when tried from any part of the stroke.

Although this is a quick and ready method of aligning, there are several important points that must be carefully noted by the engineer. The piston head may have become worn and a slack fit in the cylinder, or the gland may have become worn so that it has a slack fit to the piston rod. If adjustments are made under such

conditions, the alignment will not be positive. The stuffing-box bottom ring and the gland should be made a good fit to the piston rod and stuffing box. Then the crosshead shoe may be adjusted until the gland enters the stuffing box freely when tried from any part of the stroke.

An error in crankshaft alignment may exist in any direction, but may be located if the test is made at four equidistant parts of the revolution; for instance, at the two dead centers of the crank and at the highest and lowest positions of the crankpin.

To locate an error in any of these directions, one may use the connecting rod because, owing to the length of the rod, the error becomes magnified and is thus more plainly discernible. In using the connecting rod as a means of testing the alignment, the engineer must be sure that the bore of the large and small end brasses are at right angles with the center line of the rod.

Shaft Alignment

Suppose the engineer is testing the crankshaft for vertical alignment, the guide and crosshead pin being in alignment with the cylinder. If the alignment was correct and the connecting rod coupled up to the crankpin, the small end of the rod would come fairly in the jaws of the crosshead. But suppose the connecting-rod small end falls over to one side of the crosshead journal, as shown in *C* in Fig. 1, then the crankshaft is out of alignment in the direction shown by the line *BD*. The crank is next turned around to the opposite dead center and the connecting rod again tested with the crosshead. If the crankpin be in true alignment with the crankshaft, the small end of the connecting rod will still be thrown over to the same side of the crosshead journal,

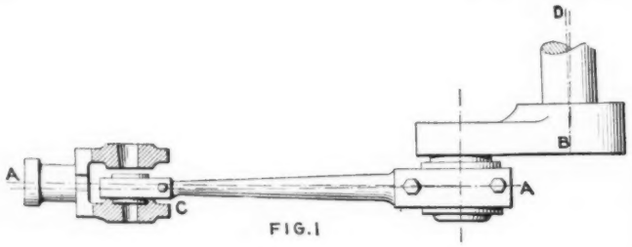


FIG. 1

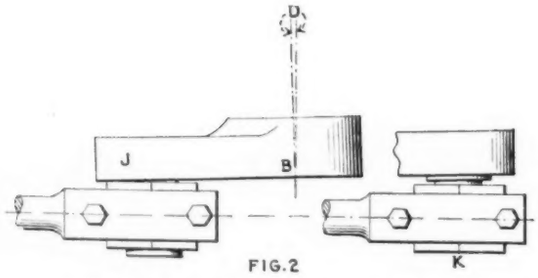


FIG. 2

FIGS. 1 AND 2—TESTING VERTICAL ALIGNMENT

but to a smaller amount. Thus by trying the connecting rod with the crank on the dead center nearest to the cylinder, the error is more plainly shown.

Let us look at the problem from the other end. If we couple up the small end of the connecting rod to the crosshead pin and uncouple the large end from the crankpin and try the large end of the rod, the crankpin being on dead center, the connecting rod will fall to one side of the crankpin as shown in Fig. 2 at *J*, but if tried on the other dead center it will fall on the opposite side of the journal, as shown at *K*.

A ready method of testing the alignment of the crankshaft which gives approximate results is shown in Fig. 3. Place the crank on a dead center, then lay a parallel straight-edge *S* along the machined face of the main bearing. A straight-edge *W* is next laid across the inside face of the crank as shown, and the distance *a* is measured. The crank is then put on the opposite dead center, and the straight-edge being placed as before, the distance *b* is measured. If the two measurements *a* and *b* are equal, the shaft is ap-

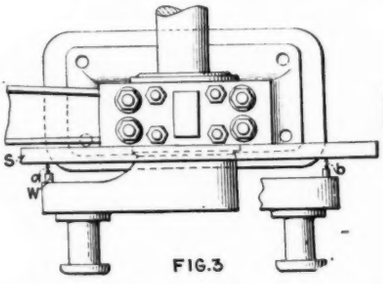


FIG. 3

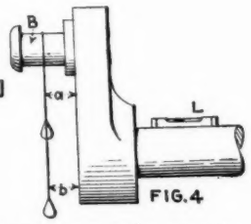


FIG. 4

FIGS. 3 AND 4—CHECKING ALIGNMENT OF THE SHAFT

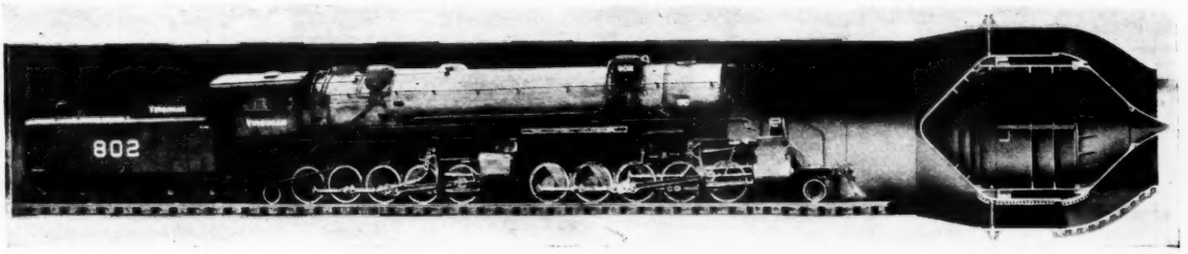
proximately true; if they are not, the main or outboard bearing brasses must be adjusted until the measurements are equal.

If the crankshaft is not level, the engine will usually thump or pound. When the pounding occurs at the end of the stroke, it may arise from a ridge in the cylinder or at the guide end or may be due to play in the connecting-rod brasses. If it occurs when the crank is at half-stroke, either the crankpin is not parallel with the crankshaft or the crankshaft itself is not horizontally true.

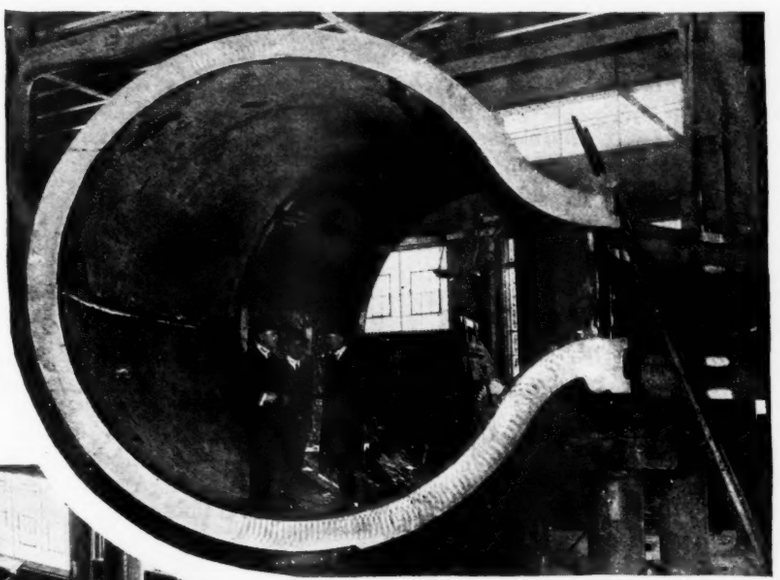
Testing Horizontal Alignment

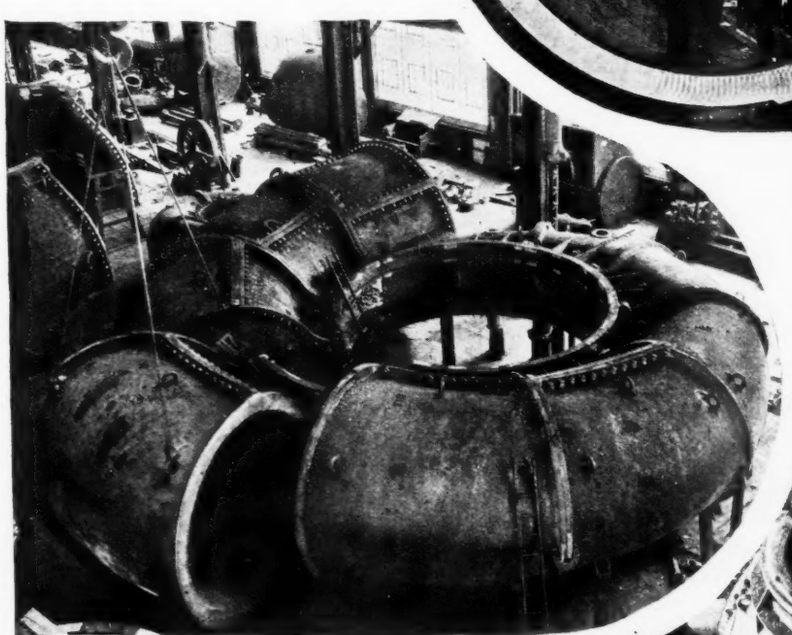
Assuming that the crankpin and crankshaft are in alignment, a simple method of procedure for testing the horizontal alignment of the shaft is to place a spirit level having a V-groove in the surface and a cross-bubble, along the top of the crankshaft, as indicated at *L*, Fig. 4. If the crankshaft is not level, the bubble will show it at once. A test for horizontal alignment may be made by a plumb-line hung over the crankpin as shown at *B*, Fig. 4; the distance *a* should be the same as the distance *b*.

An error in crankpin alignment is difficult to detect. It has already been pointed out that an error in alignment may exist in any direction, but if the test is made at four equidistant parts of the stroke—as for instance, on the two dead centers and at the highest and lowest or half-stroke positions of the crank—the error may be located. If the crankpin fails to show any error when tested by the connecting rod, it will be true enough for all practical purposes. If we take either dead center singly and connect the connecting rod to the crankpin and try it at the crosshead end and find that the rod falls to one side of the crosshead journal, it will be difficult to determine whether the crankpin is out of alignment or whether it is the crankshaft itself that is out of line. When the error is due to want of alignment of the crankshaft, the connecting rod will fall over to the same side of the crosshead no matter on which dead center the crankpin stands, but when it is due to the crankpin, the rod will fall to one side of the crosshead pin when tried on one dead center and to the opposite side when tried to the other dead center.



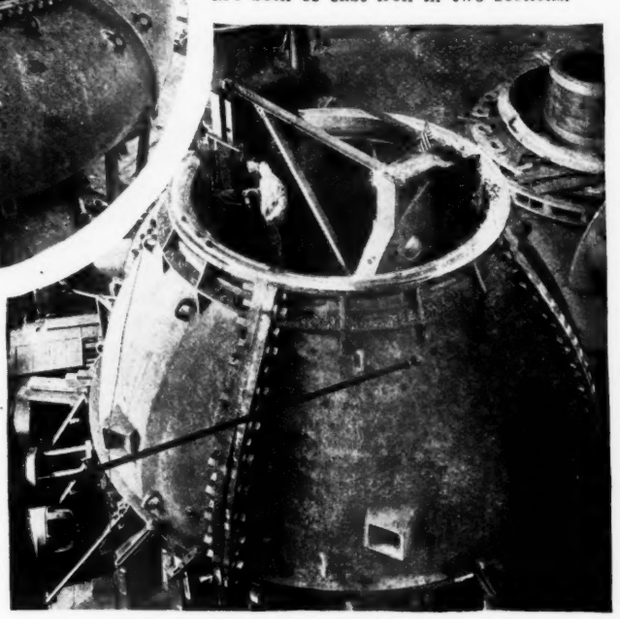
Above—Size of world's largest steel-plate penstock and Johnson penstock valve, compared with the largest locomotive ever constructed. Three of these valves are being built for the Niagara Falls Power Co. for use with the 70,000-hp. turbines to be installed in an extension of this company's Hydraulic Plant No. 3. Under normal conditions of operation each valve will discharge approximately 3,400 cu.ft. of water per second. The inlet diameter is 21 ft.; at the turbine end the diameter is 14 ft., with a maximum diameter of about 24 ft. 4 in. The operation of these valves is controlled by a system of valves admitting and exhausting hydraulic pressure to and from the interior of the plunger and the annular chamber between the outside of the valve plunger and the inside of the internal cylinder. The pressure used for the operation of the plunger is obtained from the turbine penstock.





Above—Intake end of casing for 70,000-hp. turbine. This casing has a maximum diameter of 14 ft.

Below—Downstream end of outer casing for one of the penstock valves being machined. Note that this part of the casing has been constructed around the machine tool. This end of the outer casing is made in four sections and is constructed of cast steel. On the upstream end the outer casing is of plate steel. The plunger and internal valve cylinder are both of cast iron in two sections.



Above—Last section of casing being swung into place. The casing is constructed in 18 sections. Each section is of cast steel and some of them will be cast integral with stay vanes, there being a total of ten vanes around the inner circumference of the casing when assembled. These turbines will operate at 107 r.p.m. under a 213.5-ft. head. Three of the units are being installed by the Niagara Falls Power Co., two of which and the three penstock valves are being constructed by the Wm. Cramp and Sons Ship & Engine Building Co. When these turbines are installed, they will be the largest in the world and will use the water that is now being used in two of the older plants. The units will produce approximately double the amount of power per cubic-foot-second that is produced by the old 5,000-hp. wheels. The latter are operating under a head of 140 ft. compared to 213.5 ft. for the new units.

Glimpses of a 70,000-Horsepower Hydraulic Turbine

Steam-Turbine Governors and Valve Gears—Dashpots, Synchronizing Springs and Pilot Valves*

By EUSTIS H. THOMPSON†

BALANCED-TYPE steam valves predominate in the various forms of valve gears, while unbalanced valves are used principally in those which are hydraulically or mechanically operated.

Unbalanced control valves for admitting steam to the turbines are necessarily simple in structure and require practically no adjustments of themselves. The lifting parts require special treatment in accordance with the individual design. The troubles with such valves are few in number, consisting principally of the sticking of the stems in case the improper grade of packing is used or when old packing is allowed to stay in the gland after becoming hardened. Leakage between the disk and the seat will result in overspeeding at no load in the same manner as with any other type of valve, but in this type the seating pressure is equal to that exerted by downward weight, spring pressure, if any, and unbalance in the steam pressures at the disk.

DASHPOTS are essentially simple in construction and seldom give trouble, but when carrying a widely varying load, misadjustment may make undesirable governing action. This holds true for pilot valves, steam valves, and other elementary parts of valve gears.

Fig. 1 shows in detail a control valve familiar in most large power houses. Dirt should be prevented from accumulating on the stop at *D*, which would hold the valve from closing entirely if allowed to become too thick. The rollers on the cam should be kept moving freely, so that they will not wear flat. A more comprehensive description appeared in the May 8 issue.

The balanced type of valve is used by a large number of manufacturers. These are subject to leakage, as in the unbalanced type, and in addition may become unbalanced due to unequal wear or possibly stoppage of equalizing ports. In some types the "growing," or increase in dimensions, which takes place at high steam temperatures causes binding between the valve and cage. Constant machining is necessary until the final growth has been reached and corrected. Most valves, particularly for medium or large turbines, are unbalanced to a greater or less extent, as shown in Fig. 2. The area due to the unbalance of the valve stems *A*, *B* and *C* causes an upward thrust in each case. The valve weight, however, acts downward. The valve at *A* uses a flat contact and is also unbalanced owing to the fact that the lower disk is somewhat smaller in diameter than the upper. The valve at *B* uses a line contact instead of surface contact and is not necessarily unbalanced in the structure of the disks. The valve at *C* is unbalanced in regard to areas of the disks. This represents a type of steam valve used on modern large units for high pressures and temperatures. It shuts tightly by seating on conical surfaces at the bottom of the upper and lower valve flanges. The conical surfaces of disk and seat gives flat seating contact. At *D*, Fig. 2, is shown a small valve which is completely balanced in regard to the valve stem. This is brought entirely through the valve itself, and atmospheric pressure is ported to the upper area, so that an equal pressure exists on each end of the stem.

Equalizing ports are shown in valve *A*. These assist in maintaining equal pressure at the top and bottom, in addition to the connecting ports in the valve body. Valves such as *C* usually are equipped with equalizing ports. These sometimes prevent waves or oscillations of unequal pressures. With steam pressures of 300 lb. or thereabouts, valve oscillations are at times inclined to occur, causing friction and consequently hunting, especially in a direct-driven gear.

Little adjustment is necessary in oil cylinders beyond that required on the stuffing box. Pistons sometimes work loose on shafts, due to their holding nuts backing off. Such conditions are rarely found in turbine gears.

The pilot valve, or oil relay, is the principal element of the hydraulic gear and is quite sensitive to misadjustment or wear. Friction is its most common trouble. Wear in time will cause excessive leakage, so that the gear will become sluggish or the valve unbalanced. Lost motion of the various levers results from wear and may eventually cause misadjustment of the gear travel or a surging effect in the governor. Such troubles are easy to detect and remedy. The pilot valve should fit the ports in the bushing accurately. Excessive lap will produce abnormal movement of the governor on a small change of load, while insufficient lap would make the neutral position of the valve gear an uncertain matter, so there would be a tendency of the gear to surge up and down a small amount continually. An excessive leakage at one port may cause an unbalanced valve.

Great care is necessary in renewing the bushing, which may consist of one or more parts. It is easy to destroy the delicate fit to the pilot valve by hammering this in place. A good method of driving a bushing in or out is to have a special brass rod turned up on a lathe, with a shoulder to transfer driving pressure to the bushing. New bushings are sometimes furnished with an excessively close fit to the pilot valve, so that it is necessary to adjust this valve and relieve the friction.

The pilot valve should be fitted to a new bushing after this is driven in place rather than before. Excessively low oil pressure will naturally make the valve sluggish and cause surging when the load undergoes successive changes.

Steam pilot valves or relays are subject to the same conditions as those for handling oil. It is often neces-

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sary to refit the pilot valve after it has reached operating temperature, on account of expansion. The steam may contain impurities such as lime or boiler compound which tend to stick the pilot valve and a good lubricator then becomes a necessity. These pilot valves, however, sometimes work satisfactorily without any lubrication whatever. The operating cylinder of a steam gear may or may not require lubrication, depending on steam conditions.

The pilot valve at *A*, Fig. 3, contains but a single bushing. This can be driven upward. The pilot valve at *B* contains five bushings, two of which form the seats of the pilot valve for controlling the oil supply to both ends of the oil cylinder. In taking out these bushings, it is best to drive a stick of soft wood through the three internal bushings. The entire lining is driven in one direction until one bushing at the end can be removed. This is then driven in the other direction, until the other end bushing can be removed. Driving is continued in the same direction until the three central bushings are taken out. Note that setscrews must be removed before the bushings can be taken out. The end bushings are fitted much tighter than the three internal bushings.

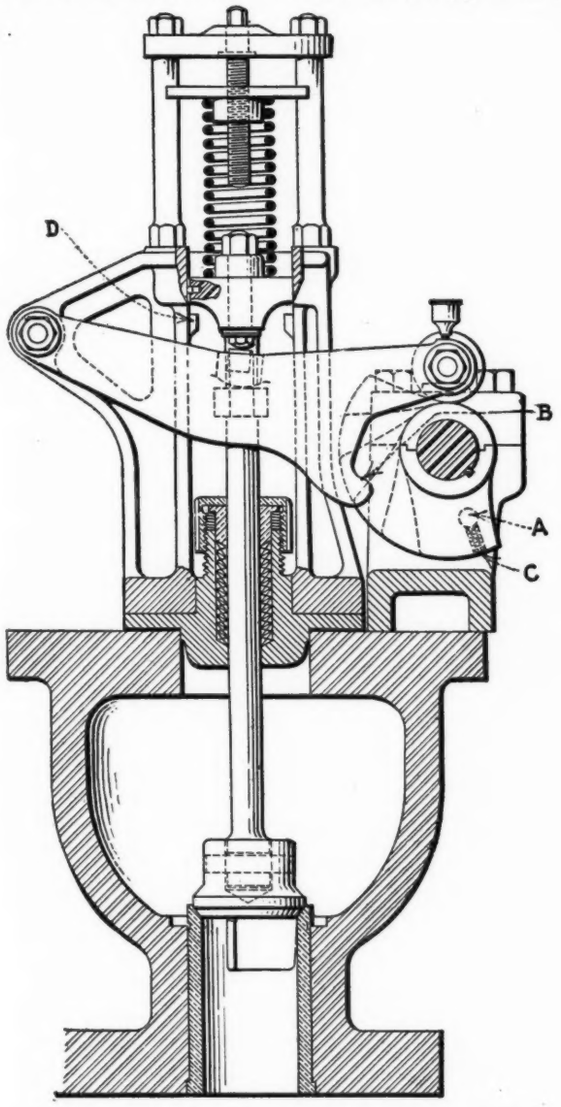


FIG. 1—STEAM PRESSURE ASSISTS IN SEATING UNBALANCED-TYPE VALVE

Dashpots are used in general for one or both of two distinct purposes: (1) In connection with a mechanical or hydraulic gear the dashpot dampens regular pulsations normally produced in the links of the valve gear and prevents them from affecting the governor; (2) dashpots are also placed on valve gears where regular pulsations do not necessarily exist, but which may be subject at times to pulsations. The functioning of both types is described in the June 19 issue.

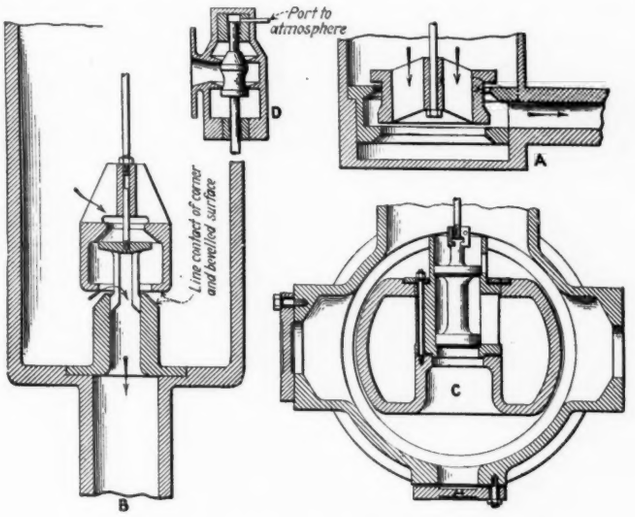


FIG. 2—INLET VALVES OF THE BALANCED TYPE

Dashpots of the first division should be given sufficient friction to dampen out the pulsations to the required extent, but no more. Movements of the governor necessarily must move the plungers of such dashpots, and therefore, as little friction as possible is desirable so as not to impede the movements of the governor. An excessive change of speed or perhaps surging might otherwise result on a change of load. A good rule to follow is to adjust the dashpot so that a small amount of pulsation can be seen in the plunger. This should not be enough to cause undesirable oscillation of the governor, but should be fairly close to this condition. The dashpot will then present the least tendency to impede the movements of the governor.

Dashpots of the second class should be set with as light a friction as will give satisfactory governor action. Excessive friction will impede the movements of the governor, and in order to avoid this, the lightest friction that will produce the required result should be the aim of the operator. It is desirable to test the dashpot with some quick changes of load, such as opening or closing a switch, to give a large variation of load. It is more convenient, as a rule, to throw the load off. A sudden change of one-quarter load to one-half load should ordinarily be sufficient. The dashpot friction should be set so it is too light and then gradually increased until excessive surging or jerking is barely dampened out.

It may happen that the heaviest dashpot friction adjustment is too light for the valve gear. In this case, as no more adjustment is possible, friction can be increased by filling with a heavier grade of oil. If satisfactory operation cannot be obtained by adjusting the dashpot on the variations of the station load, it will be necessary to go to the trouble of producing special load variations.

In some cases no bypass is provided and a selection of the proper grade of oil is all that is necessary. Friction naturally becomes greater as the viscosity of the oil is increased. When using light oils, it is advisable to guard against a grade that will evaporate readily. Cylinder or gas-engine oil represents the heaviest grade and is seldom required. Sometimes a mixture of this oil and light oil is satisfactory. In special cases where greater viscosity is required glycerin may be employed to advantage.

Some dashpots, as at *D*, Fig. 3, are equipped with spring tension valves in the plungers, which open on a quick movement of the governor so as to allow more rapid operation. These should be adjusted to seat properly with sufficient tension. Ordinarily, surge valves are not provided.

It may be desirable to give the dashpot an absolutely permanent adjustment. A certain grade of oil may be used so that proper action will be assured if it is kept filled with this oil. The bypass may be eliminated so as to prevent this being tampered with. A good method of adjustment in such a case is to plug the bypass and drill one or more holes straight through the plunger, until a proper friction is produced. In case too much of an opening is made, a hole can easily be plugged up and a smaller one bored. Proper action will then depend only on using the required grade of oil.

The mechanical adjustment of dashpots is a simple matter, nevertheless troubles are sometimes encountered. The most important thing is to see that the plunger does not bind or stick, but has a fairly neat fit. If there are high spots in any portion of the plunger travel, surging may be produced. The plunger should fit easily so that it will not bind on expansion, and it should be made certain that binding is not produced by impurities or sticky matter contained in the oil that is being used. In order to make proper plunger travel, the dashpot should be lined up accurately to avoid all tendency of the plunger to tip over and cause binding. On the whole it is desirable to use a fairly loose-fitting plunger rather than a neat fit. This refers to the plunger itself and not to the piston rings, which latter, if used, are supposed to fit closely on account of their own elasticity.

The plunger should be carefully checked to see that its holding nuts are locked in a positive manner, so that they cannot come loose. It is important also to see that the plunger has proper travel to allow for the necessary movement of the governor, with plenty of clearance at each end of the governor travel. Dashpots should be carefully shimmed and doweled to position so that they can readily be removed or replaced when it is necessary to repair adjacent parts of the valve gear. Dashpot covers are usually screwed or bolted on. In the former case the cover should be turned up quite tight to prevent its working loose during the operation of the turbine and possibly limiting the downward stem travel.

Valves that are placed in the plunger often wear out. Plungers or nuts may work loose and drop down. Trouble is often caused by the oil evaporating or leaking, so that the oil level in the dashpot becomes too low. Bad pulsations sometimes occur in the governor due to this cause. The dashpot should be cleaned periodically to prevent dirt accumulating and interfering with the plunger action. Dashpots require inspection and cleaning at regular intervals as well as other members of the valve gear, and should not be neglected.

Dashpots in all cases should be adjusted with as small a friction as will answer the purpose. Binding of the plunger readily causes surging of the governor. Bypass adjustments may be eliminated by drilling holes in the plunger to give correct friction with a chosen grade of oil.

Synchronizing springs are essentially simple in construction and operation. Those described in previous articles exert a pull in one direction only. In some cases the spring exerts a force that tends to slow down the governor so that with very light tension the governor speed will be high, due to the adjustment of the governor spring itself. This is an opposing-type spring, as described in the May 22 issue. Many manufacturers use springs that function on the opposite principle, so as to assist the pull of the flywheel, and by pulling on the governor links raise the speed of the turbine. Occasionally, a third type of spring is met with, which exerts no pull in the central or neutral position, but may exert either tension or compression on either side of neutral adjustment, depending on whether the speed is to be raised or lowered in regard to this central point. This construction may be applied to either an opposing or assisting type. Motor-driven springs are used almost exclusively. On small turbines springs of this kind are sometimes employed for varying the speed where the turbine is used for the prime mover of a pump, etc.

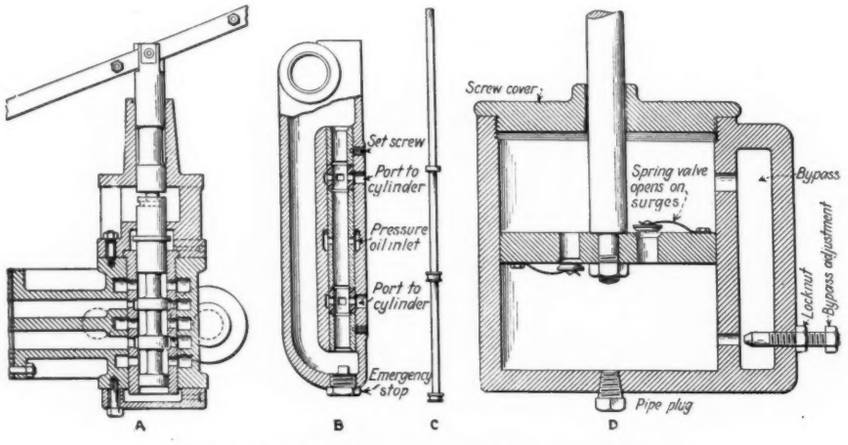


FIG. 3—PILOT VALVES MAY CONTAIN ONE OR MORE BUSHINGS

Special troubles are seldom encountered with these springs. In some cases excessive tension or compression is exerted, which tends to heat up or wear out the governor-transmission bearing. Such springs sometimes fail in operation by ripping threads or teeth of their operating parts, so that the speed of the turbine is affected abnormally. Matters of this kind are too well understood for special comment. The speed of the main governor should be so adjusted that the smallest force that is consistent, will be exerted on the main lever in normal operation, by the synchronizing spring. This throws a minimum amount of work on the transmission bearing.

Reminiscences of a Veteran Mechanical Engineer—II

First Meeting with Henry Rossiter Worthington, Sen., and Work Done for Him at the Centennial Exposition in 1876

By W. H. ODELL

In this series of articles, which began in the June 19 issue, Mr. Odell tells amusing and interesting incidents connected with his activities and acquaintance with many of the notable and pioneer engineers of the past generation—a few of them, fortunately, still with us. In the July 3 issue he will tell of some of the trials that James Blessing encountered in connection with his steam loop.

AFTER two years' practice with the indicator it became evident that as a profession it would not pay. The first year's work brought in about $600, the second about $800, and as it became necessary to increase my income, it was thought advisable to try for a position as chief of a city water-works pumping station. With this thought in mind, Mr. Worthington was called on at his office on Broadway, near Murray Street, New York City, and this interview will never be forgotten.

After I had presented my card and stated the object of the call, Mr. Worthington seemed lost in thought for a few seconds, then looked up, with that smile on his face that has endeared him to all who knew him well, and asked, "Do you know why you cannot make this business a success?" Receiving a reply in the negative, he said, "You are ten to twelve years ahead of the age." Then followed an interview in which he talked to me like a father; said he had no control over his pumping engines after they were turned over to the cities, but he would gladly give me work in his shop, which at that time was located at the Erie Basin, Brooklyn, N. Y. Not wishing to go back as far as the machine shop after tasting the sweets of a professional life, I thanked Mr. Worthington and went out.

However, I wanted to do something to show how I appreciated his kindness, and the thought came that if I secured employment in his shop under an assumed name, it would take only a few weeks to learn all the minute details of construction that might be of use later on if opportunity presented to advocate the use of goods manufactured at his work. This I did, and am happy to say in passing, the opportunity did come to show I had not forgotten.

But, to return to my experience in the shop: I had been employed about five weeks as a floor hand, when one afternoon Mr. Travis, the works superintendent, came through the shop with a well-known marine inspector who knew me and hailed me with, "Why, Odell, what are you doing here?" Mr. Travis was equally surprised and wanted to know why I had not applied for work under my right name and said he would have put me in charge of a gang. After stammering out as good a defense of such conduct as possible, the offense was forgiven because of the motive that lay behind it, and the indicator work was resumed.

Mr. Worthington, as the inventor of the direct-acting steam pump and the plunger water meter, is so well known that it seems superfluous to say much about his

HENRY ROSSITER WORTHINGTON
From a mezzotint taken from a painting.

skill as an engineer and inventor; but it may not be generally known to our younger generation of engineers, that among other enterprises he built a boat to be operated on the canals with steam as the motive power; and possibly more may be said about this boat later on, but at present the object is to show the kindly nature of the man whose great enterprises did not harden his heart. At the time referred to, I am advised he had about two hundred men employed in his works and apparently knew and called each one by his given name and seemed to take a fatherly interest in all of them. Just before he retired from business, and while I was having an interview with him regarding a proposed duty test, he complained about his head, said he had fearful headaches, etc., and in reply to a question as to why he did not give up business and stop burning his candle at both ends, the reply was, "Yes, but you

know I have so many depending on me"; and that seemed to be one of the chief objects of his life—to help others to help themselves.

It has already been said that at the date referred to he had about two hundred men employed at his works in South Brooklyn. At the present writing, William Schwankauser, chief engineer of the Worthington corporation, advises me that there are between 4,000 and 5,000 employees. What a wonderful growth in a few years!

In reference to the necessity that led to the invention of the direct-acting steam pump, I will quote from a letter written by Mr. Worthington to a well-known engineer many years since.

> Somewhere about the year 1840 I was engaged in experimenting with a steamboat designed for canal navigation. It frequently happened that the boat was suddenly stopped by unexpected impediments in navigation or detention at locks. This often brought a hand pump into lively requisition for keeping up the boiler supply, and naturally turned my thoughts toward a labor-saving method. The result was the independent feeding pump, patented on the 7th day of September, 1840. . . . I made many of these, and their action was satisfactory to a surprising degree . . . but it proved to be dangerous, just in proportion as it seemed to be reliable. It would perform its duty so long and so well as to lull the attention of the attendant to sleep and almost insure an accident if perchance someone of the numerous infirmities of machinery should render the apparatus inoperative. It was here learned to dread and condemn all automatic contrivances for superseding the attention and responsibility of attendants. As applied to boilers, I am convinced that they tend to danger.

This device, as it may be noted, was automatic in its action; controlled by the water level within the boiler, but it also marked the birth of the independent steam pump, which was developed into the present-day pumping engines for city supplies, etc.

Mr. Worthington's contribution to the Centennial Exposition at Philadelphia in 1876 was a three-million-gallon pumping engine installed on the Schuylkill River just outside the grounds to furnish the water supply for the exposition. Having been engaged by Mr. Worthington to represent his company at the exposition, space sufficient for a desk and chairs was allotted me in the hydraulic annex.

My chief duty was to meet engineers interested in hydraulics and, as occasion required, escort them to the pumping plant. This necessitated not only the payment of their entrance to the grounds on the return trip, but also my own. This did not seem right, and I appealed to George H. Corliss, with whom I was well acquainted at the time, and who was one of the exposition commissioners as well as an exhibitor, and in acknowledgment of the justice of the claim he had a special pass issued, authorizing the keeper of wagon gate No. 5 to open the gate and permit bearer with five other persons to enter without passing through the pay turnstiles; and I may be pardoned if I say, at this late date, that not one person entered through that gate unless he had first paid his way into the grounds.

Recent experiments in England have shown that steam issuing from the nozzle of the diaphragm of an impulse turbine does not follow the general direction of the nozzle outlet. Instead, it is deflected somewhat against the rotation of the wheel or, in other words, is bent away from the diaphragm so that it makes a greater angle than that of the nozzle.

Reasons for Lack of Economy in Refrigerating Plants

There are many more factors that have an influence on the economy of a refrigerating plant than in the case of a steam power plant. Unfortunately, many engineers do not understand the theory of refrigeration as well as they do that of the steam engine, and it is not surprising that operating results are often disappointing. This can be improved upon by a close attention to the important details of operation.

The suction pressure caused in the coils has a decided influence on the cost of refrigeration. As a general rule the suction pressure should be carried as high as possible. By reference to an ammonia table it will be found that each pressure has a corresponding pressure at which the ammonia will boil. As example, if the suction pressure is 20 lb. gage (35 lb. absolute) the boiling temperature will be 6 deg. This, then, is the temperature of the ammonia in the coil when under a pressure of 20 lb. Since the reason the ammonia boils is the absorption of heat coming through the pipe wall from the cold-storage room or brine tank, there must be a higher temperature in the room or tank than in the coil, or no heat would flow. A difference of 12 deg. is fair, so that a 19- to 20-deg. cold-storage room temperature will be about correct with a 20-lb. coil pressure. This is the room temperature close to the coil; the room temperature at some distance from the coils may be in the neighborhood of 25 to 30 degrees.

Cause of Low Suction Pressure

Now in many plants where the cold-storage temperature is held at 20 deg. F., the coil pressure must be carried much below 20 lb. The important point is for the engineer to discover the reason for the discrepancy. A low suction pressure may be caused by lack of coil surface, ice on the coils, oil and scale in the coil, or too small an amount of liquid ammonia going through the expansion cock.

Taking up these suggested causes in turn, only a certain amount of heat can pass through each square foot of coil surface per hour per degree of difference between the outside and the inside temperature. If there is not enough surface, which means an ample number of coils, the amount of heat passing through the coil wall to the ammonia is not equal to the heat seeping into the room from the outside. To cause the two heat flows to be equal, the heat flow to the coils must be raised by increasing the difference in the ammonia and room temperatures, for the coil-surface area is fixed as is also the coefficient of heat transfer per square foot per degree of temperature difference. The choice lies between allowing the room temperature to rise until the heat flows are balanced or to lower the temperature of the boiling ammonia in the coils. If the latter is done, the suction pressure must be lowered. As has been indicated low pressures are expensive, consequently more coils should be installed in order to increase the absorbing surface.

The second and very common cause of low suction pressure is heavy ice or frost on the outside surface of the coils. Air can carry a certain amount of water vapor depending upon the temperature. As the cold-storage doors open and close, warm air from outside enters, and as the air grows cold, it can carry but a small amount of water vapor and the rest settles on

the coils as frost or ice. Cold-storage products, such as meat, likewise give off a considerable amount of moisture which congeals on the pipe. This frost increases the thickness of substance through which the heat must flow to reach the ammonia, and to maintain the same rate of heat flow the temperature difference must be increased. This is done by lowering the suction pressure. The engineer will understand how this lowering is brought about. Usually, the room temperature is noticed to be rising, and to bring it down to normal the compressor is speeded up. Since a greater volume of ammonia gas is being drawn out of the coils than the ammonia is evaporating, the coil pressure drops.

Effect of Oil Deposits

Where oil in any great amount is fed to the compressor, unless an efficient oil separator be installed in the discharge line, the oil will carry over into the coils. Even with the best of traps a part of most ice-machine oil will vaporize under the ordinary compressor discharge temperature. No separator can take this oil gas out of the ammonia gas, and it passes to the condenser, where it liquefies and flows along with the ammonia to the coils. Being in the form of an emulsion, it settles on the inside surface of the coils in a sticky mass. This film has a high resistance to heat flow, and so to keep the room temperature low enough the suction pressure must be pulled down. To correct this defect the coils should be blown out at the first opportunity. Steam is the best means of removing the oil.

Still another cause of low suction pressure is too small a flow of liquid ammonia through the expansion cock into the coils. If the flow of ammonia be small, it will flash into vapor as soon as it enters the coil. As the vapor passes through the long coil to the compressor, it becomes superheated; that is, it absorbs heat and its temperature rises about the boiling temperature.

Since a pound of ammonia vapor will absorb only about one-half a heat unit per degree rise in temperature, it is plain that even though it reaches 20 deg., the same as the room temperature, the superheated vapor can take up but 10 B.t.u. per pound, whereas in boiling each pound took up around 480 B.t.u. The room temperature will rise unless the suction pressure be pulled down enough to allow the ammonia when superheated to take away as much heat as is entering the room from the outside. This usually is an impossible feat. Opening the expansion cock and so increasing the flow, permits more or all of the coil to be filled with ammonia, and since more ammonia is boiling, more heat is absorbed and the pressure may be allowed to rise to its correct value.

High Condenser Pressures

Not only does a low suction pressure cause inefficient operation, but a high condenser pressure has the same detrimental effect. It increases the horsepower requirements of the compressor and causes the compressor to run much hotter, causing the packing to wear rapidly and also causing more of the lubricating oil to leave the compressor in a vaporous condition.

With the ammonia vapor coming to the compressor in a dry condition, for every given condition of suction pressure and of discharge pressure there is a discharge temperature that is obtained under ideal conditions. By ideal conditions is meant a state of affairs where no heat is added to or abstracted from the gas during compression save the heat of the work of compression. This ideal temperature for different suction and discharge gage pressures may be found from a heat diagram; see *Power*, Sept. 26, 1922. As example, with a suction pressure of 20 lb. gage and a discharge pressure of 150 lb. gage the suction temperature is 6 deg. and the ideal discharge temperature is 205 deg. F. The engineer can determine how near he is approaching this ideal condition by using a thermometer on the discharge line. Even though the ideal temperature is reached, it should not be taken as proof that the plant's operation is good. The discharge pressure is directly dependent upon the condensing temperature in the condenser. As example, if the water temperature is 70 deg. the temperature of the ammonia should be about 82 deg. Referring to the ammonia tables, this will be found to correspond to a pressure of 160 lb. absolute, or 145 lb. gage. The discharge pressure is never so low as this; that is, the pressure is always higher than that corresponding to 12 deg. plus the water temperature.

Air in System

Many things cause this difference in pressure. In the first place the presence of air in the ammonia vapor will cause an increase in pressure, since the pressure in the condenser is the sum of the pressure exerted by the ammonia and the pressure exerted by any air or foreign gases in the system. By purging off this air, the pressure may be reduced somewhat, but there will always be an excess of pressure of 10 to 20 lb. due to the air that cannot be entirely removed.

Lack of sufficient cooling water will also cause the pressure to be high. This is because, with a small supply, there is not enough water to take up all the heat in the ammonia without a large increase in the water temperature. If the temperature of the water going off is over 15 deg. higher than the water going on, the supply is too small.

Even with an ample water supply the condenser pressure will be high if the amount of condenser surface is scanty. Since the amount of heat removed depends not only upon the temperature, but also upon the amount of heating surface, the condenser should be ample.

Scale on the inside of a double-pipe condenser or moss and dirt on the outside of an atmospheric condenser will interfere with the heat passage from the ammonia to the water. The remedy is to keep the condenser clean.

In many plants the receiver is placed in the engine room. This means that after being cooled in the condenser, the ammonia enters the receiver and absorbs heat for the engine room. Any forecooling that was accomplished in the condenser is thereby lost. The proper location for the receiver is in some other part of the plant.

Evaporators may be classified (1) by the number of effects, as "single-effect," "double-effect," "triple-effect," etc.; (2) by the pressure of the steam supplied, as "high-pressure" (live steam) or "low-pressure" (exhaust-steam); (3) with high pressure, as "high-heat-level" or "low-heat-level," according to whether the last-effect vapor gives up its heat to the feed water in the range above or below 212 deg.; and (4) according to the construction and operation of the individual effects, as "submerged-tube," "film-type," "flash-type," etc.

The Hyperbo-Electric Flow Meter

As a fluid in a pipe line passes through an elbow, the enforced change of direction causes a centrifugal force that increases the pressure against the outer wall. This pressure increases with the velocity of the flowing fluid and may be made the basis of a method for metering the quantity passing.

The swirls and eddies set up in an ordinary elbow interfere with any definite relation between pressure difference and rate of flow. The Hyperbo-Electric Flow Meter Co., of 207 South Green St., Chicago, claims to have demonstrated, however, that in an elbow having a rectangular hyperbolic section, preceded by an approach bell and straightening grids, as shown in Fig. 1, a definite relation exists between the average velocity through the central section, or 45-deg. plane, of the elbow and the difference in pressure between a given point on the outer curve and another point on the inner cruve of the elbow, both of these points being in the 45-deg. plane, or plane of symmetry, as it is called.

Once a plane streamline flow is obtained by means of the grids and the hyperbolic elbow, the relation between pressure and centrifugal force becomes fixed, and because of the dependence of centrifugal force upon velocity, the relation between pressure and velocity can also be calculated. It is an easy matter to measure the pressures at selected points along the 45-deg. plane. This plane has a definite known area, and the velocity of the fluid crossing it has a definite relation to the difference of pressure between two points of this plane. For example, one at the outer curve of the elbow and another at the inner curve will determine the average velocity, and, therefore, the rate of flow.

The meter body (see Fig. 1) consists of a vertical flanged cast-iron cylinder closed at both ends. In its base is an annular insulated cup filled with mercury, the remainder of the cylinder being filled with an insulating oil. In this oil rides a hollow float of non-conducting material kept in position by two vertical guide wires. The float carries a ring of over 120 vertical nickel contact wires of graduated lengths, connected together at their upper ends through uniform electrical resistances. The tube *A* transmitting the higher pressure of the hyperbolic elbow, extends through the mercury cup into the inside of the bell float, and the lower-pressure pipe *B* enters at the top of the cylinder. When the pressure difference is zero, all the contact wires are short-circuited by the mercury, but with changes in pressure difference the float rises or falls, moving the contacts out of or into the mercury contained in the cup. With equal resistances between contacts, the lengths of the wires have been stepped to conform to a logarithmic curve. The resulting electrical resistance through the meter body is proportional to the logarithm of the pressure difference developed at the elbow. The reason for this will be given later.

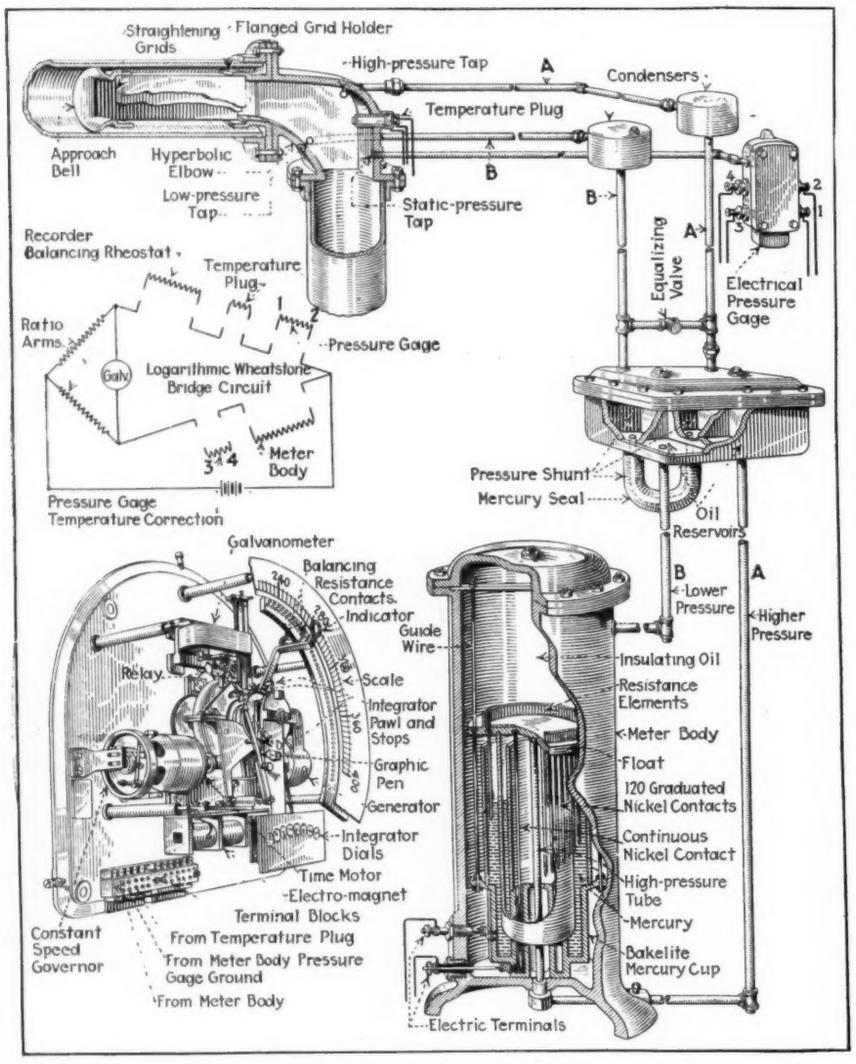


FIG. 1—HYPERBO-ELECTRIC FLOW METER

In the case of gases, the pressure difference is transmitted by the gas itself entering the float and the meter body, while with water or steam the pressure is transmitted through the movement of an insulation oil, 25 per cent heavier than water, flowing in and out from external oil reservoirs, filling the float as the latter rises and simultaneously releasing oil from the meter body outside the float, and vice versa. The division between the water (condensed steam) and the oil is effected in the oil reservoirs shown in Figs. 1 and 2.

This device is a casting separated into four cells or compartments by division walls in the body and cover. The two cells on either side constitute, respectively, the high- and low-pressure elements of the casting, the former having a pressure connection to the outside curve of the elbow, while the low-pressure side is connected to the inner curve of the elbow. Between the two sides there is no connection except through a mercury seal, below the reservoirs, installed to protect the meter body, and a valved equalizing line joining the pressure pipes above the reservoirs. This valve is normally closed.

From the elbow the pressure connections first pass to condensers, hollow castings for condensing the steam, and continue to the reservoirs, a connection being made to a compartment on either side. These compartments are filled with condensation, as are the pipe lines above and the condensers to the level of the pressure connections. On both the high- and low-pressure sides there is a connection to the second compartment which is filled partly with oil and partly with condensation, The oil, being heavier, is at the bottom. From underneath these compartments connections lead to the meter body, as previously explained.

To avoid inaccuracies from variations in voltage, a recorder was developed to measure the electrical resistance, rather than the current, in terms of pounds per hour or other desired units. It is virtually an automatic ohm-meter working on the basis of comparing the resistances to be measured with an adjustable known resistance, their relation becoming definite when the deflection of a galvanometer of the suspension type is reduced to zero.

In saturated-steam measurements, the density of the steam varies with the pressure, so that, for accuracy, a pressure correction is necessary. If the steam is superheated, there is need also for a temperature correction. In the case of water a temperature correction is called for, and with gas there must be corrections for temperature, pressure and specific gravity. The square root of the combined product and ratio of these factors is involved in flow metering. To correct for these various factors and to combine them in the proper products and ratios, the resistances have been made up proportional to the logarithms of the factors they measure. These resistances, in conjunction with the resistance in the meter body, are connected in a Wheatstone bridge circuit, shown in Fig. 1. The act of balancing the combined resistances by means of the known resistance actuates the meter indicator, and automatically converts the pressure difference at the elbow into units of flow and at the same time applies corrections for all the various factors that determine the flow of the fluid being measured.

To multiply and divide automatically more than the three factors to which the ordinary Wheatstone bridge is limited and to provide an evenly divided scale and direct reading indicator, graphic chart and integrator, it was necessary to devise a logarithmic Wheatstone bridge. This device operates on the basis that the sum of the logarithms of any number of variables is equal to the logarithm of the product of all those variables, and since any number of resistances can be connected in series, their sum, and hence the product of the factors they represent, may be obtained.

Current at 30 volts is supplied to the electric circuit by a small generator. A motor using any convenient supply of current, such as a lighting circuit, drives the generator, also the recorder mechanism and the graphic chart. Once every five seconds the motor, operating through a worm gear rotates the mainshaft of the recorder. Through an arrangement of gears and pawls this rotates the indicator arm, which is in contact, through a set of copper brushes, with the balancing resistance elements of the Wheatstone bridge circuit. When the circuit is balanced, a relay operated by the galvanometer brings the pointer to rest. **A four-throw cam on the main shaft insures the repetition of this balancing operation every 1¼ seconds.**

The indicating dial is 16 in. in diameter and covers an arc of 240 deg. Within the circle of the dial is the graphic chart which is 9½ in. in diameter. It is made to rotate once in 24 hours or once in seven days, as desired. The graphic pen is geared to the indicator arm.

Operation of the integrator is on the basis of a continuous addition of indicator readings every five seconds. During this period a continuously rotating arm with a pivotal pawl at its end makes a complete revolution. At a fixed zero position the pawl is engaged automatically with an integrating ratchet wheel and remains so until disengaged by a stop on the indicator arm. Thus it travels through an angle equal to the deflection of the indicator arm from its zero position, and as the indicator scale is uniform, this angle or deflection is proportional to the indicated load.

It will be recalled that automatic correction is made for variations in steam pressure. The electrical pressure gage used for this purpose (shown diagrammatically in Fig. 3) operates on the principle of a mercury manometer with one end closed. The steam pressure, transmitted through the insulating oil with which the outer mercury is covered, determines the height of the central mercury column. This, in turn, regulates the amount of resistance in a series of coils which form part of the Wheatstone bridge circuit. Correction for the temperature of the inclosed air is made by a coil having a suitable temperature coefficient.

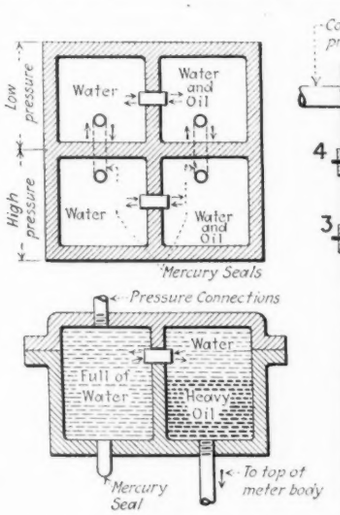


FIG. 2—RESERVOIRS FOR TRANSMITTING PRESSURE TO INSULATING OIL

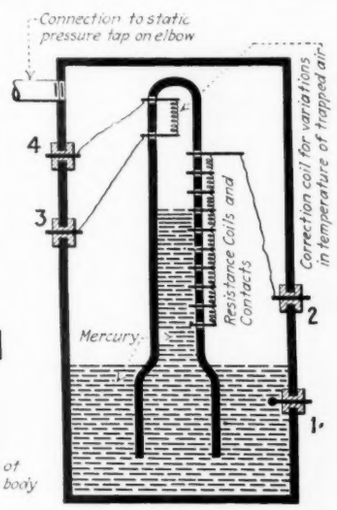


FIG. 3—DIAGRAM SHOWING PRINCIPLE OF OPERATION OF PRESSURE GAGE

The temperature plug, used to correct for changes in temperature when the steam is superheated, is incased in a brass or monel-metal tube screwed into the elbow measuring the flow. The plug has wire connection with the Wheatstone bridge and operates on the principle that changes in temperature cause changes in resistance. Elements of two materials with different resistance temperature coefficients are connected in series and so proportioned that the resultant resistance temperature coefficient gives the required correction.

As to the accuracy of the flow meter, the readings are guaranteed to be within 2 per cent of the actual flow, between 15 and 100 per cent of the meter rating, and within 4 per cent of the actual flow from 5 to 15 per cent of rating, allowing pressure variations of 20 per cent above or below rating and any temperature or specific gravity variations.

Graphical Analysis of Operating Results

By Johnstone Taylor

Figures relating to coal consumption per unit generated in an electrical power station are likely to be taken too much for granted as being accurate. While power-station engineers no doubt give these results with the greatest honesty of purpose, more often than not the coal burned per kilowatt-hour is nothing more than an estimated monthly average.

Of course some plants have elaborate means of weighing the coal and measuring the water evaporated, and with chain-grate stokers the coal meter is a simple and fairly accurate contrivance, while modern methods of measuring condensate and feed leave little to be desired.

Even, however, with means of obtaining the coal consumption and water evaporation of every shift, these figures should be studied intelligently and compared shift by shift with a standard of performance for the station.

A good way of doing this is by means of diagrams. Assuming that the station operates three shifts a day, there will be 84 shifts in a period of four weeks. On a large-scale diagram with the weight of coal per shift (say, in thousands of pounds) as ordinates, and the kilowatt-hours generated per shift (in thousands) as abscissæ, the coal consumed on each shift can be plotted. There will, in the case cited, be 84 records, and these will be found to arrange themselves in groups.

The curve drawn through these points is of considerable value inasmuch as from it can be ascertained the average coal consumption corresponding to any given

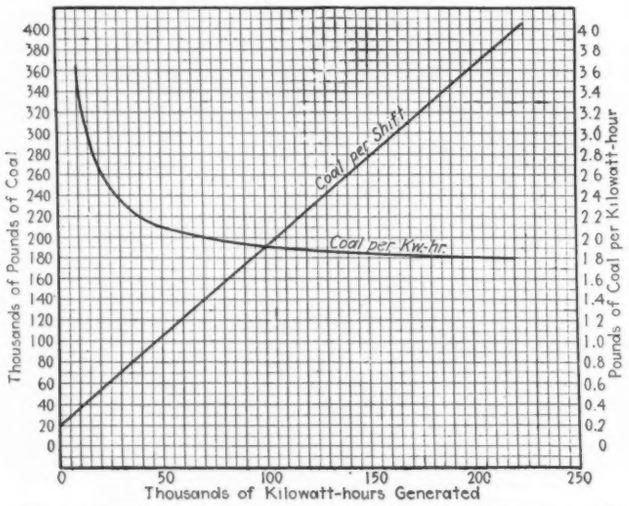


FIG. 1—RELATION BETWEEN COAL CONSUMPTION AND OUTPUT PER SHIFT

output (both based on one shift), and this, when divided by the figure of output, gives the coal consumption per kilowatt-hour for that output.

A curve showing how the coal consumption of the plant per kilowatt-hour varies with the output can then be plotted on the same diagram, as shown in Fig. 1. Another diagram is now required having the water evaporated per shift (in thousands of pounds) plotted as ordinates against a base of kilowatt-hours generated in thousands. Here again there will be 84 points through which a line is drawn. A curve can then be calculated and plotted to show the pounds of water per kilowatt-hour for any output. Examples of such curves are shown in Fig. 2.

Referring to Fig. 1, which applies to a large power station, the stand-by losses appear to account for 20,000 lb. of coal per eight-hour shift, while every kilowatt-

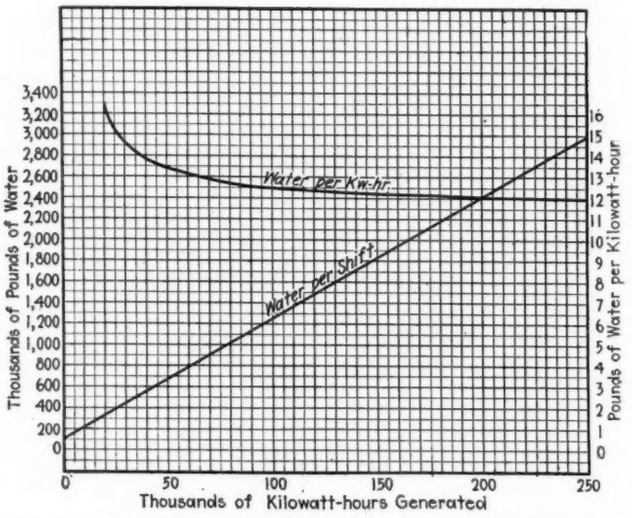


FIG. 2—RELATION BETWEEN EVAPORATION AND OUTPUT PER SHIFT

hour generated accounts for 1.72 lb. of coal and (see Fig. 2) 11.54 lb. of water. These figures represent the coal and water consumption to which the station is tending. From Fig. 2 it will be seen that in a condition of stand-by, ready to take up load instantly, the minimum steam used would be 100,000 lb. per eight-hour shift.

The constant 1.72 is arrived at, of course, by dividing the total quantity of coal burned on any one shift, less the no-load consumption of 20,000 lb., by the number of kilowatt-hours generated. The equation for coal consumption per shift would be

$$\textit{Pounds per shift} = 20{,}000 + 1.72 \times \textit{kilowatt-hours per shift}$$

By comparing the results obtained on any shift with those plotted, it is easy to see whether the efficiency is improving or not.

It cannot be too strongly emphasized, however, that the vital figure in power-station operation is the quantity of coal used per kilowatt-hour. This, as well as the water evaporated, must be recorded shift by shift. By so doing, the superintendent has in his hands the key figures for checking *at once* any deterioration in efficiency. Records like these have a value far exceeding the trouble involved in arriving at them. An analysis of operation records on the lines indicated provides a ready means of picturing the operation of a plant.

In designing stacks for power houses, it is customary to allow a considerably greater wind pressure at the top of the stack than at the bottom. In some methods of designing, however, the wind pressure is considered as constant throughout the entire height.

Valves and similar fittings for high pressures and temperatures, as used abroad, are in most cases of comparatively thin and flexible construction.

EDITORIALS

F. R. LOW, EDITOR

A Far-Reaching Decision

A DECISION handed down on June 11 by the United States Supreme Court, invalidating the law passed in the State of West Virginia compelling natural gas companies supplying gas taken from within the state to supply consumers within its borders in preference to those outside the state, should have a healthy effect upon some other state legislative bodies who have apparently forgotten that their respective states are still parts of the United States. A law that is invalid when applied to natural gas should also be invalid when applied to hydro-electric power. Therefore the decision against West Virginia is virtually a decision against those states that have proposed laws against exportation of power from the state where it is generated.

Since the war there has been a general realization of how dependent the various nations of the world are on one another, and that one cannot suffer an economic loss without affecting the others. How much more is this true of our own states? This fact, however, apparently has not worked its way into the heads of some of those who have been assigned the privilege of making laws.

It is difficult to imagine what would happen if each state had absolute control of the natural resources within its borders and attempted to exercise those rights. If, during last winter's coal shortage, the State of Pennsylvania had been granted the power to supply its own needs for coal without due regard for other states that depend upon this source for a supply, the shortage would have been much more acute. Our power systems are fast becoming interstate in their dimensions and cannot be operated to give any state a particular advantage, any more than the free operation of our trunk-line railways can be interfered with by imaginary lines called state borders. This is not a question of who shall develop the power resources, but can one state interfere with the free development of power, an industry that has become our most important? The United States Supreme Court's recent action amounts to a decision that the nation's interests cannot be subjugated to any particular state.

Power-Station Ventilation

FIREMEN toiling in the fierce heat of summer boiler rooms or subjected to alternate blasts of heat and cold in the winter, may look forward to more humane working conditions when the investigation now being made by a section of the N.E.L.A. Prime Movers Committee begins to bear fruit. Far too little attention has been given to power-plant ventilation, although some modern plants show a great improvement over the older ones in this respect. The average fireman—and often the engineer and owner as well—looks upon heat, dirt and general discomfort as the normal lot of the boiler-room worker. Yet most of this discomfort can be avoided if proper attention is given to the matter when the station is designed.

Boilers require an enormous amount of air; each ton of coal takes from 300,000 to 400,000 cubic feet of air for its combustion. Where boilers operate under forced draft, there is nothing to prevent drawing a large part of the combustion air from some high point to which the heated air, dust and gases of the boiler room would naturally rise by convection. The boilers, with their stacks and draft fans, necessarily constitute a vast exhausting system, which can be made to draw air from any desired spot by the proper arrangement of ducts and natural air passages. Consideration must, of course, be given to the equal amount of new air which sweeps into the boiler room to replace that passing up the stacks. To admit this air directly from outdoors may cause bad drafts in the winter time, but these may usually be prevented by drawing the new air from the upper portions of the operating room, thus utilizing the waste heat from turbines and steam piping. Here again, advantage may be taken of the natural course of convection currents to obtain adequate ventilation with the least possible use of ventilating fans.

As pointed out in the report of the subcommittee on power-plant ventilation, the problem is more complicated than that found in heating and ventilating the average public or private building. Particular care must be taken to avoid the condensation of moisture or the formation of ice on monitor skylights and other cold surfaces of the operating room. The equipment and operating force may generally be protected against such formations by the proper use of dead-air spaces.

The investigation is still in progress, and the present report makes only preliminary recommendations of a general nature. There are, however, so many sound suggestions in what is now presented that operators and designers may confidently await, in the final report, a practical solution of the power-plant-ventilation problem.

A Single Standard Desirable

NO ONE feature in electric-motor applications has attracted more attention during the last seven years than the double temperature-rating standards for general-purpose motors. Advocates of each rating have advanced strong arguments for their respective preference. The strongest opponents to the fifty-degree rating have been the users of the motors and in some cases the electrical manufacturers themselves. The Electric Power Club recently rescinded its two adopted temperature standards for general-purpose motors and in their place recommended a single rating; "an open-type general-purpose motor shall be capable of carrying full rated load continuously with a temperature rise of not exceeding forty degrees centigrade." It is the sense of the club that general commercial practice during the next year will probably lead to the unanimous adoption of a single rating standard without overload reference of any character. If this proves to be the case, the club will have solved one of the most trouble-

some commercial engineering problems in the application of electric motors.

Many of the prominent industrial engineers have strongly opposed the fifty-degree motor as one that had no factor of safety, the full-load temperature being one just within the safe limit. On the other hand, there appears to be no good reason why a motor should be given an overload guarantee rating above a continuous rating with a liberal temperature factor of safety. This is the course advocated by the Electric Power Club and is one that should receive the support of motor users.

A double standard rating is undesirable, as it not only leads to confusion among motor users but also tends away from standardization and uniformity. The adoption of a dual rating has never been fully warranted, and a number of the electrical manufacturers have never subscribed to the higher temperature rating. If the load on a motor could be predetermined in all cases with a high degree of accuracy, then rating this equipment with a close margin of safety might be justified. But there are many uncontrollable variables entering into the problem in many applications that exclude any close loading of the motor. Even when the load can be determined accurately, standard sizes of motors in many cases will preclude any exact motoring of the equipment.

What the average user of motors is more interested in than close rating of temperatures is service from the equipment after it is installed. He is aware that an overloaded motor is liable to burn out and cause serious interruptions to production and expensive maintenance charges. Unless there is definite information available as to the exact power requirements for his machine, the inclination is to be on the safe side and over-motor. In direct-current work the most serious objection to this practice is the excess cost of the motors, although it is probable that within reasonable limits this excess cost is largely offset by a reduction in maintenance charges. In alternating-current applications the bad effects of overmotoring on the power factor of the system is ever present. However, this is not going to be prevented by any dual standard of motor ratings, but by a dissemination of more accurate information on the exact power required to drive the different classes of machinery.

Four Advantages of Closed Turbo-Generator Ventilation

SINCE the advent of the turbo-generator dirt has caused great inconvenience in connection with generator windings. In the case of alternating-current generators with forced ventilation, dirt sometimes accumulates very rapidly. The result of this condition is brought forcibly to the front in the analysis of the operating records of a group of turbine-generators in the recent Prime Movers Report of the N.E.L.A.

Seventy-six per cent of the generator repair and maintenance time was devoted to armature and field windings and cleaning them. In the main dirt is the principal offender. The continual use of fresh air for cooling, no matter how well it may be washed, builds up dirt deposits rapidly. The best solution at hand is closed system recirculation of air, cooled by sprays or cooling coils if the service demands require long operating periods.

It will be seen from this report that twenty per cent of the repair work of the prime movers under discussion was due to the generator. Since seventy-six per cent or in other words three-quarters of this amount, was due to windings of the generator, the generator windings are responsible for fifteen per cent of the repair work required of the entire units. Eliminating dirt by the use of closed generator air circulation may render unnecessary a large proportion of this fifteen per cent of repair work. It should also be remembered that one-half of the prime-mover outage time is due to the turbine elements, most of which were undergoing repairs involving a change of design of the rotating element. We may expect in the near future that such remaining repairs on the present units will be largely accomplished and the turbine outage reduced in proportion. The outage due to the generator may then be a much larger factor than twenty per cent of the total time. It may be expected therefore, that a similar report next year would show a still greater percentage of loss due to cleaning dirt from the generator windings, unless conditions are improved.

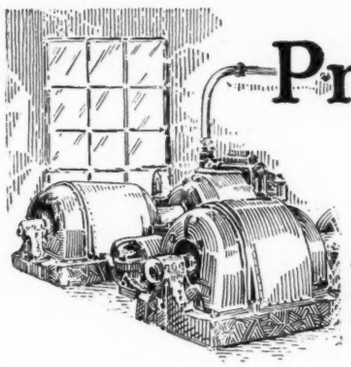
The impetus that prime-mover insurance has recently received will undoubtedly react on power plants in furnishing an incentive to improve conditions that will contribute the lowest possible rate of insurance. The closed system of generator ventilation is looked upon with favor in this regard, as oxygen that may be effective in case of fire is thus confined to that contained in the air circulating system. By using nitrogen or deoxidized air for this system, the fire risk will be further reduced.

Cooling apparatus for the closed ventilating system offers another means of increasing the over-all efficiency of turbine units. Surface coolers have been operated in systems of this kind for reclaiming heat otherwise lost to the atmosphere.

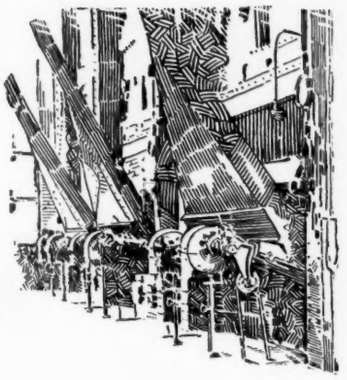
The fourth advantage that may be obtained from closed generator ventilation seems to have escaped the attention of engineers in general, but represents a means of greatly improving power-house conditions. Power companies that are alert to the welfare of their employees have, in many instances, fitted up the interiors of large central stations with many conveniences and have given careful attention to appearances. A power house or large central station is highly important as the heart of a manufacturing plant of an industrial community. Not only this, but intensive execution and correct judgment are essential to its normal operation. Improvements tending to benefit the operator in the discharge of his duties are therefore well justified.

In spite of all that has been done for the comfort, convenience and efficiency of the men, many large concerns place the operating force at an appreciable disadvantage by permitting the distracting noises caused by air discharged from the generator to fill the turbine room. The intensive nerve strain is immediately felt by a stranger entering such a plant, where conversation can not be carried on in a normal manner. Although the operator may become accustomed to it, clear thinking and accurate judgment are impeded.

While catering to the efficiency of the operators in other respects, many appear to consider a discord, resembling that of a boiler shop, entirely a thing to be expected. Those desiring to ameliorate the physical handicap at present imposed by such a disagreeable condition, will find the closed system of generator ventilation to be a means of greatly reducing this factor.



Practical Ideas *from* Practical Men



Millivoltmeter Burned Out by Changing the Shunt

A maintenance man, while testing the charging current on a storage battery with a millivoltmeter and shunt used as an ammeter, found that the shunt was too large and he decided to use one of smaller capacity. When changing connections, there was a puff of smoke from the instrument and he found it completely burned out.

The original connections are shown in Fig. 1. In changing to the small shunt, one line wire was first

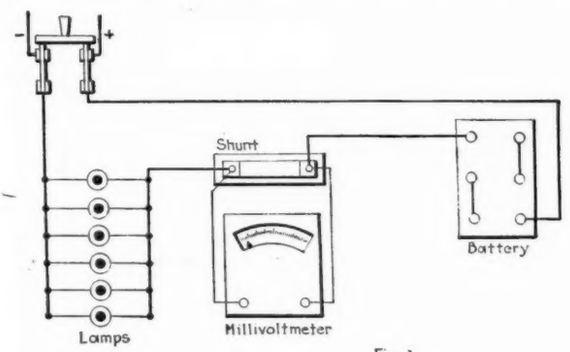


Fig. 1

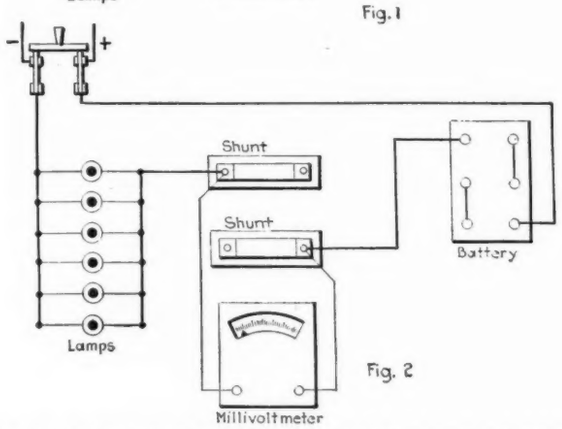


Fig. 2

FIGS. 1 AND 2—MILLIVOLTMETER CONNECTED TO SHUNT
Fig. 1—Correct connections. Fig. 2—How meter was connected when it was burned out.

removed from the large shunt to the small. Then one millivoltmeter lead was changed from the first shunt to the second, when the burnout occurred. As will be seen from Fig. 2, with this connection the full charging current passed directly through the winding of the instrument, while normally these parts carry only about 25 or 30 milliamperes.

Therefore it should always be borne in mind when changing shunts, especially if the current is not turned off by an auxiliary switch, to (1) remove both millivoltmeter leads from the first shunt and (2) connect both leads to the second shunt. Then the line wires may be changed as desired without danger of damaging the instrument. Another dangerous practice is to remove the leads from a millivoltmeter and let the ends dangle around loose, for many a meter has been burned out by these free ends touching conductors of high enough potential to ruin the instrument by instantaneous contact.

VICTOR H. TODD.

Summit, N. J.

Burning Waste Fuel of High Moisture Content

The method we use for burning waste product containing 80 per cent moisture may be of interest to *Power* readers. In the operation of our plant we were confronted with the problem of finding a suitable dumping ground for several tons of refuse per day as well as the expense of hauling, so we finally decided to try burning it in the boiler furnace.

Our plant consists of horizontal return-tubular boilers fired by underfeed stokers. Several methods of burning the refuse were tried without success, when finally we discovered the most successful way was to operate the stokers with coal as usual and then to open the furnace doors and throw in about all the refuse the furnace would hold without completely covering the burning coal; in fact, the wet fuel was thrown against the furnace walls. We not only find this to be the cheapest way of disposing of the wet fuel, but by an evaporative test considerable steam is made thereby.

Detroit, Mich. WALTER MIDDLEDITCH.

A Double Air-Tank Explosion

In San Francisco recently, two air containers connected together exploded simultaneously in a violent manner, wrecking adjacent parts of the building in which they were located.

The tanks were set horizontally, one above the other, the lower resting on wooden cribbing and the upper on the two 6-in. flange couplings by which it was connected to the lower tank. Both tanks were old boiler shells with tubes removed and solid heads installed. The lower one was 54 in. in diameter and 15 ft. 3 in. long over all. The shell was in four courses of $\frac{3}{8}$-in. plate with double-riveted lap seams. Dished heads, cut from $\frac{3}{8}$-in. tank steel, and concaved to pressure, were autogenously welded to the shell in the manner shown in Fig. 1. These

heads were dished not to exceed five inches and were unbraced.

The upper tank was in three courses, $\frac{7}{16}$-in. shell with double-riveted lap longitudinal seams. Flat heads were riveted to the shell and properly stayed with crowfoot braces. The head that blew out had a manhole with reinforcing ring riveted in.

Two belt-driven compressors delivered air to these tanks through a common line. Automatic unloaders were

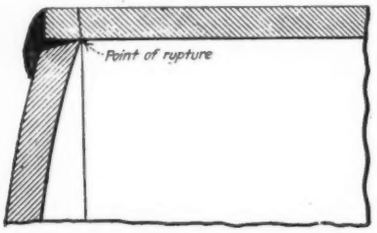


FIG. 1—METHOD OF WELDING DISHED HEAD IN THE LARGE SHELL

set at 42 lb. and were operating properly when tested immediately before the accident. A spring pop safety valve in perfect condition was connected in the delivery line and another direct to the upper tank, which was also equipped with a small lever safety valve. The pop valves were set at 50 lb. and did not blow, immediately before the accident.

When the attendant came on duty Sunday morning, the tanks were being supplied by one compressor. He started up the other compressor, tried the unloader and safety valve as usual and cut it into the line. He then stepped to the control board for the motor driving the first compressor and tripped by hand the automatic control switch to shut the compressor down. Immediately there was a rumble, and the explosion occurred.

The head of the large tank was blown to the street and was found about 150 ft. from the plant in a direction at right angle to its original course. The fracture was in the shell plate around the entire circumference of the shell immediately adjoining the welded head seam. The cross-section of the metal showed extreme crystallization to a depth of $\frac{3}{16}$ in. from the outside surface of the plate.

The head of the small tank broke around the fillet of the flange. The heads of the crowfoot rivets broke off and the rivets pulled through the holes in the braces, leaving the holes intact. The head separated through the manhole.

The flange connections between the tanks were broken as well as the entire piping system between tanks and compressors. A brick wall separated the tanks from the compressors. The tanks backed up against this and demolished it completely. One tank struck the 9-ft. flywheel, the sudden stoppage of which broke the 2-ply, 27½-in. leather belt, sprung the shaft of the 200-hp. motor and bent the 2½-in. diameter idler rods. The attendant probably owes his life to the presence of the wall.

The writer attributes the explosion to ignition of oil vapor within the tanks, and this decision is borne out by the following facts: (1) The walls and roof timbers in front of the tanks were sprayed with oil from the interior of the tanks, and part of the woodwork immediately caught fire. (2) The internal surfaces of the tanks were coated with oil, much of which had been carbonized, showing that combustion had taken place within the tanks, if only for a brief period. There was also considerable black-looking oil found in the bottom of the tanks after the explosion. (3) A 2½-in. brass-body globe valve, located in the air line 150 ft. or more from the tanks, was torn open and a 2½x6-in. galvanized iron pipe nipple adjacent to the valve burst open and flattened out like a piece of rolled plate. (4) The gates of two 6-in. gate valves, remotely located in the line, were cracked in two pieces and near-by the center was blown out of a 2½-in. cast-iron pipe plug screwed into one opening of a tee.

These results point to an explosion so sudden and violent in its nature as to be better described as a detonation. Certainly, the mere sudden release of the air stored at 42 lb. pressure would have had no such effects as those described. Assuming that the explosion was caused by ignition of explosive or inflammable vapor or gas within the tanks, it would be interesting to learn the opinions of engineers regarding the probable manner in which ignition was brought about. It is a subject well worth investigation, and if there are practicable preventive measures they should be given wide publicity. Had this accident occurred any other day than Sunday, there might have been many lives lost, and had the tanks been set in any other direction than toward a large door, the damage might have amounted to a large sum.

The average air-tank user ignores the latent destructive energy stored within a tank and looks with dis-

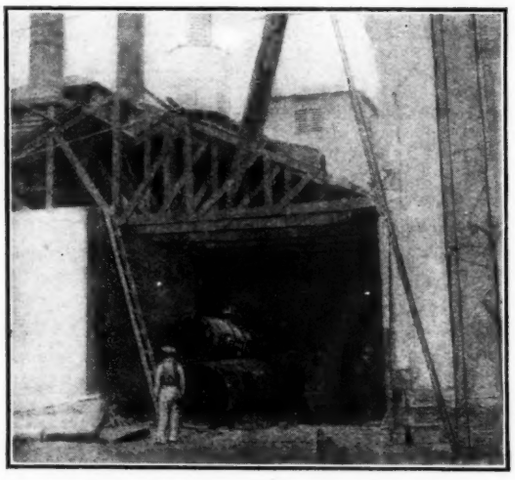


FIG. 2—GENERAL VIEW OF EXPLODED TANKS AND DAMAGE TO BUILDING

favor on advice as to its safety. He may be ever so particular about a steam boiler, but any sort of shell is good enough to hold air. Why not give the air-tank publicity? Recent years have brought an enormous increase in the number in use and the services for which used, also an alarming increase in the number of violent, destructive air-tank explosions.

San Francisco, Calif. A. J. LAMIE.

When turbines were first built, it was considered that there was no trouble to be feared from deflections in the bedplates. It was found out, however, that turbine bedplates are readily deflected in sufficient amount to cause serious misalignment. When this fact was realized, manufacturers introduced delicate methods of checking steam-turbine alignment when being installed.

Comments from Readers

Recommends Parallel Operation of Industrial Plants and Central Stations

A number of the more prominent American engineers are recommending and advising that our large office, hotel and other buildings and all our larger industries install private power plants; also that these private plants be operated in conjunction with existing heating plants in the industries, and that whenever possible they should be operated in parallel with local central stations.

In a certain plant in Indiana we had a 375-kva. turbo-generator unit we operated in parallel with the central station, with great saving to ourselves and benefit to the central station and its consumers on the same power circuit.

In this plant we regulated the load on the unit to give the desired volume of exhaust steam for heating during the daytime, the central station furnishing all excess power required.

A few departments were required to operate all night, and during this period the power unit generated an excess amount of power (as we carried sufficient load to heat the plant), which was returned to the central station to balance the amount we had used during the daytime. This plan assisted the central station in carrying its peak load at night, as well as during the day.

The central station's "demand charge" was $1 per kva. transformer capacity, and we seldom permitted our power bill to exceed this charge.

Other manufacturers on the same power circuit were greatly benefited, as line losses were practically eliminated and the voltage was maintained at a constant and maximum figure. When our unit was cut off the line, the voltage of the power circuit dropped, causing much inconvenience to other factories.

While the central station lost practically all the revenue we formerly paid it, it is probable that the improvement in service to other industrial plants on the circuits fully compensated for this loss.

Of course central stations are usually opposed to private industrial power plants, but we shall attempt to show that while private power plants will reduce gross revenue, they will increase net profits of the central stations.

The total output of the central station must be sold at sufficient rates to average over 3c. per kw.-hr. to prove profitable. This rate will vary according to local conditions and investment, but probably is close to a general average. Therefore, if the larger part of the total output is sold to large consumers at 1 to 2c. per kw.-hr., such business becomes unprofitable and drags down the profits of the entire output; while a smaller percentage of total output may be sold at the low rates mentioned and still prove profitable.

To illustrate this point, I will give the actual experience of a 12,000-kva. central station in Indiana.

During the month of June, 1921, the plant output fell about 40 per cent below normal, owing to the depression of industrial plants, yet the central station showed a net earning of several thousand dollars; while during June, 1922, the plant output was about normal, but the gross earnings were $900 below the gross operating expenses during this month, which proves conclusively that this particular station was carrying an excessive amount of low-rate unprofitable load.

There is no doubt that the central stations, in their eagerness to secure business, have gone too far in the industrial field; the value of each industrial contract has not been carefully analyzed, with the result many have proved unprofitable to both the seller and buyers.

A central station, or any business for that matter, can afford to sell a certain proportion of its total volume of business at a very low rate, even at or near cost, provided the volume of the low-rate business does not exceed a certain well-defined ratio to the volume sold at much higher rates. If this ratio is exceeded sufficiently, any business will prove a financial failure if the practice is continued.

The average sales department of central stations does not consider the important factors outlined in the foregoing, and its efforts are directed almost entirely to increasing the volume of business irrespective of the rates charged and consequent benefits or losses to the central station.

Some large consumers are unprofitable. To illustrate this point, assume the following case: Jones & Co., requiring 200,000 kw.-hr. a month, looks like an easy power prospect; the sales department closes the contract at an average rate of, say, 1½c. per kw.-hr.; this business will then increase the central station's gross revenue $3,000 a month. But will this enhance the profits? Very little, if any, provided the central station is supplying many other firms at the same rate. In the event that it is the only consumer of this size and all other consumers are paying much higher rates, then, and only then, will such consumers prove profitable.

Suppose, however, the same 200,000 kw.-hr. were sold to ten smaller consumers, each requiring 20,000 kw.-hr. a month, and were charged the customary rate for this volume of business, 3c. per kw.-hr. The ten smaller consumers will increase the gross revenue of the central station $6,000, which would be decidedly more profitable.

From what has already been said, it is evident that central stations can and frequently do actually place themselves in a financially embarrassed position by supplying power to large consumers whenever the volume of such low-rate business exceeds certain proportions of gross output.

The 20,000-kw.-hr. consumers and those consuming less may and should be classed as legitimate central-station business, as such consumers are always profitable to the central stations and are usually benefited by purchasing power from outside sources.

On the other hand the Jones & Co. referred to, and other consumers requiring over 20,000 kw.-hr. a month,

should be classed as, and are, illegitimate central-station business, because such volumes of power cannot be generated and sold by central stations at the proper rates to prove profitable to either the seller or purchasers.

There certainly is no material margin of profit in electric energy sold at less than 3c. per kw.-hr. even when generated by the largest power stations; hence the average rate for the entire output must exceed this rate in order to prove profitable as an enterprise.

The average rate certainly cannot equal 3c. if a certain volume of output is sold below this rate.

In the event that industrial plants, office and other large buildings install their own power-generating units to be operated in conjunction with existing heating plants and run in parallel with local central stations, there is no doubt that these industries would utilize central-station service during overtime and light-load periods and hence would become "small consumers" and as such would pay much higher rates for the power purchased.

Under the circumstances mentioned, these consumers would become profitable to the central stations, whereas as large consumers they certainly are unprofitable.

Of course this plan would materially decrease the gross revenue of the central stations, but there is no doubt that the net profits would increase.

In the event that the industries of the country will install their own power units as suggested, the millions of kw.-hr. capacity released from central stations, may and should be utilized much more profitably in operating our railroads, which could start electrifying at once, as available power would enormously decrease necessary investment.

The thousands of industrial power plants all tied together through the central stations, and the latter in turn tied together, would constitute one really practical gigantic national super-power plant of far greater and more real value to the country as a whole than the proposed superpower plants for a few congested districts.

If the industrial power units are used as they should be, simply to extract power already generated and available, from the steam generated for heating and manufacturing purposes, enormous quantities of coal will be conserved, as the power so generated is actually a by-product of the heating fuel, and hence consumes no additional fuel.

Millions of dollars have been invested in stations to enable them to serve industrial plants for only 50 hours a week, and this enormous investment, or at least a large part of it, is idle the rest of the time, eating up interest and labor charges, which of course are paid for by the consumers in the "demand charges."

As the consumers must pay for the continuous expense of interest on investment, no matter who owns the plant that supplies them with power, it is better that they should pay the interest on their *own* power plant than somebody else's, as in the case of central station supplying power, this interest must be paid each month whether it is convenient or not, while in the latter case the interest is seldom actually paid out in cash, but is purely a matter of bookkeeping.

Furthermore provided the industrial power plants were operated in parallel with central stations during the heating season at least, they would be operated 24 hours a day continuously in order to provide necessary heat; this would bring down the cost of both heating and power and result in benefit to the central station, especially during-peak load periods.

In an article in the March 27 issue, R. S. Hale, superintendent, Special Research Department of the Boston Edison Electric Illuminating Co., shows that he at least, has come to realize the sentiment or awakening of both central stations and industrial managements, that the former have gone too far in the industrial field and the time has come for corrective measures; he naturally suggests parallel operation of the industrial plants with the stations.

Other prominent engineers have advocated the plan, and Europe has been following it successfully for years.

Erie, Pa. S. J. H. WHITE.

Determining the Consumption of Steam Jets

I read with interest the article by E. E. Harper "On Determining the Consumption of Steam Jets" in May 8 issue.

With regard to the amount of steam used by nozzles, there was published in the June 16, 1920, issue of *Engineering*, the complete detailed results of investigations I carried out to determine the amount of steam used by the nozzles on 130 boiler plants in Great Britain in many different industries, corresponding to 437 boilers, mostly of the cylindrical type, with a total coal bill of approximately 1,000,000 tons per annum. Tests were conducted on 19 different types of steam-jet apparatus, of which 11 were on hand-fired furnaces and 8 on boilers equipped with mechanical stokers.

Space does not permit giving the detailed figures for each of these 130 tests, but the average amount of steam used by the 11 types of hand-fired furnaces, comprising 54 boiler plants, was 6.6 per cent of the total production of the plant. The 8 different types of mechanical stoker, fitted on 76 plants with a total of 288 boilers, gave almost identical figures for the steam consumption of the nozzles, being 6.7 per cent of the production of the plant. The figures of the whole 130 tests, however, showed an amazing variation from about 0.5 per cent to no less than 21.5 per cent in one case, an almost incredible amount. It can be taken, however, at any rate as far as Great Britain is concerned, that the average amount of steam used by nozzles is about 6.5 per cent of the production of the plant, an enormous figure and much more than is commonly supposed, the makers of these appliances usually confessing to a modest 1 to 2 per cent of the production when pressed on the point.

As I have pointed out on various occasions, in my opinion there is only one method of working steam nozzles, at any rate in an installation of any size, and that is with an entirely independent steam pipe for the whole of the nozzles, and equipped with a steam meter so as to keep a continuous record of the steam consumption. If this were done, I think that most users of steam nozzles would discover that the consumption is much higher than they realize.

With regard to the method of testing, as I have explained previously, I have used an apparatus that I devised specially for the purpose, which consists essentially of a surface condenser. That is to say, the whole of the nozzles and equipment is taken out of the boiler and fitted into an inclosed water-cooled cylinder in front of the boiler, so that all the steam blows through the nozzle, is condensed, and weighed as water. Mr. Harper recommends the old method of blowing steam into a weighed amount of cold water for a certain time and then reweighing the water. I am not quite clear whether this method is scientifically correct. When I

first started testing boiler plants and found that the steam nozzles were taking 6 to 7 per cent of the production of the plant, instead of about 1 per cent, I soon found myself in violent conflict with the makers of these appliances, and one of the strongest points urged against me was that I used the method Mr. Harper suggests. The nozzle makers insisted that this method was totally wrong as it caused a vacuum at the point of the nozzles and tended to draw more steam through the nozzles than would have been the case if the steam had been blown into air in the ordinary way. It was for this reason that I devised the surface-condensing apparatus, which, although more clumsy, is accurate without doubt. I would like to see published some results of experiments that prove whether this method of determining the steam consumption of nozzles is accurate or not, by comparing the results either with a calibrated steam meter or some form of surface-condensing apparatus. DAVID BROWNLIE.

London, England.

A Russian Oil-Engine-Electric Locomotive

Newspaper copy is not always to be recommended as the basis for technical discussion. *Power's* editorial entitled, "Here is Another," on page 144, Jan. 23, relative to a phantom Russian locomotive consuming 13 pounds of naphtha to haul a 500-ton train a distance of 400 miles, is an example of what may happen under such circumstances.

According to the testimony of Mr. Makhonine, the inventor, this locomotive operated for more than a year and a half over most of the trunk lines in Russia and covered more than 300,000 miles. It would haul a 500-ton passenger train slightly more than 400 miles in about 8 hours without stop. Its consumption for this run averaged 70 pouds of fuel oil, whereas the antiquated and battered oil-burning steam locomotives with which it was competing over the same road consumed about 930 pouds, or 13 times as much, for the same run with the same weight of train. Now the poud is a Russian unit of weight closely equal to 36 pounds. The consumption of the Makhonine locomotive was therefore about 2,520 lb. of fuel oil for the 400-mile run, or about 0.0126 lb. per ton-mile. During these runs the train consisted of eleven day coaches and one sleeper. The locomotive itself weighed 80 tons.

How are these results attained? Unfortunately, the inventor is not yet at liberty to divulge the technical details of his locomotive, and this fact, coupled with the alleged performance and the rather fanciful description of the motive plant as a "thermo-electric transformation," offers fertile ground for suspicion. Yet the inventor's explanation of his reasons for reticence is perfectly plausible, and he undoubtedly deserves a suspension of judgment until he has had time to protect his rights. The plans of the locomotive were on the verge of completion at the outbreak of the revolution of 1917. In the disruption of public services resulting from the overthrow of the czarist regime, the Russian patent office was completely disorganized. A few months later a second upheaval occurred, and the Soviet Government was established, abolishing patent rights along with other rights of the individual.

Rather than wait for better times, Mr. Makhonine preferred to run the risk of losing the rights to his invention; he succeeded in awakening the interest of a body of workmen in the Baltik Werke, the largest railway-shop and shipbuilding concern in Petrograd. An old Pullman car was remodeled under his direction into a locomotive, and placed on test Oct. 1, 1919. Whether to protect himself or because he was unable to find engineers to drive his locomotive, the inventor drove it in person. After a year and a half of continuous service, during which he made two and even three round trips a week, his health broke down, and he obtained permission to leave Russia. It is true that his locomotive has been idle since his departure, for the simple reason that no workman has been initiated into the details of the control and operation, and that, thus far, no engineer capable of working them out by himself has offered his services to the present government.

Since that time the inventor has been as busy as his health would allow, making patent applications in France and Germany to cover the different parts of his engine; and it is quite natural that he should keep the technical details secret until he has completed these applications. It is hoped that a complete technical description will be available for publication in the American press within a few weeks.

Let us now return to the consumption figures given herein, and attempt a brief analysis to determine as far as possible whether they belong to the realms of fact or fancy. The Makhonine locomotive consumes, on the average, 0.0126 lb. of fuel oil per ton-mile, on an eight-hour non-stop run, at an average speed of 50 miles an hour. Now, though we know little about this engine, we do know that it is an electric locomotive equipped with a generating plant to produce its own power, and propelled by electric motors. Therefore the energy consumption of an ordinary electric passenger locomotive should give us an indication of the amount of energy that the generating plant will have to deliver to the motors per ton-mile.

According to A. H. Armstrong, in the "Standard Handbook for Electrical Engineers," 1915 edition, the input to an electric passenger locomotive hauling a 500-ton train at a constant speed of 50 miles an hour on a level and straight track, is 395 kilowatts. The energy consumption of the motors per ton-mile is therefore 395,000 watt-hours divided by the train weight and by the distance covered in one hour; that is,

$$\frac{395{,}000}{500 \times 50} = 15.8 \text{ watt-hours per ton-mile.}$$

The heat equivalent of this energy is $15.8 \times 3.415 = 54$ B.t.u. per ton-mile.

This represents the energy output of the generating plant of the locomotive. To estimate the input to the prime mover, we can assume the maximum thermal efficiency of the set to be, roughly, 25 per cent, including prime mover and generator. It seems unlikely that this efficiency could be surpassed in normal operation. Therefore the heat input to the prime mover should be at least 216 B.t.u. per ton-mile.

Assuming the heating value of Russian fuel oil to be approximately 22,000 B.t.u. per pound, the amount of oil required per ton-mile will be $\frac{216}{22{,}000} = 0.0098$. This figure should be considered as a theoretical minimum, unattainable because the train cannot run at a strictly constant speed and because of curves and hills encountered in the line. The fuel consumption of the Makhonine locomotive is 28 per cent above this limit and is therefore well within the bounds of possibility.

Paris, France. R. H. ANDREWS.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Steam Used for Oil Burning

In using oil fuel for boilers, what percentage of the steam generated is used in the burners for atomizing the oil and delivering it to the burners? W. P.

The amount used by different kinds of burners for atomizing the oil varies from 0.3 to 0.7 lb. of steam per pound of oil, and the percentage used of the steam generated varies from 1½ to 6. A statement of percentage of total steam generated is misleading as it depends on the evaporative efficiency of the boiler. In average practice the amount of steam required for atomizing is roughly 2 per cent. The oil-pressure pump and oil heater require about 2 per cent more, so that the total steam consumption is in the neghborhood of 4 per cent of the steam generated.

Breakage of Exhaust-Valve Connecting Rod on Greene Engine

We have a Greene engine on which the connecting rod of the crank-end exhaust valve is continually breaking. What may cause the trouble? T. J. S.

This rod vibrates through a wide angle, and unless the rocker arm and stud carry the swinging end of the rod in true alignment, it is subjected to severe bending stresses, especially when the gridiron exhaust valve offers unusual resistance to movement, as when the engine is operated with high initial pressure of steam or high compression. Another cause for short life of the rod may be the form of screw threads. Sharp V-threads are likely to induce fracture. The Whitford form of screw thread should be used, rounded at the roots to a radius of 0.1373 of the pitch, and all connections from the eccentric to the valves should be taken up, so there will be no pounding.

Weight of Air at Given Pressure and Temperature

What would be the weight of 90 cu.ft. of air at the pressure of 500 lb. per sq.in. absolute and temperature of 60 deg. F.? A. C.

A cubic foot of dry air at atmospheric pressure (14.7 lb. per sq.in. absolute) and temperature of 32 deg. F., weighs 0.080728 lb., or 1 lb. has a volume of 12.387 cu.ft. For a given weight of air at constant pressure the volume varies directly as the absolute temperature, and for a constant temperature the density or weight per cubic foot varies directly as the absolute pressure. The zero of absolute temperature is 460 deg. below zero of the Fahrenheit scale, and if a cubic foot of air at the absolute pressure of 14.7 lb. per sq.in. and temperature of 32 deg. F., or 460 + 32 = 492 deg. absolute, has received sufficient heat to raise the temperature to 60 deg. F., or 460 + 60 = 520 deg. absolute, the pressure remaining constant, the volume would be $\frac{520}{492}$ cu.ft. Then if this volume of air, weighing 0.080728 lb., were to be compressed from the pressure 14.7 to 500 lb. per sq.in. absolute and brought to the same temperature of 60 deg. F., the volume would be $\frac{520}{492} \times \frac{14.7}{500}$ cu.ft. As the weight per cubic foot would be $0.080728 \text{ lb} \div \left(\frac{520}{492} \times \frac{14.7}{500}\right)$, 90 cu.ft. would weigh $90 \times 0.080728 \div \left(\frac{520}{492} \times \frac{14.7}{500}\right) = 233.8$ pounds.

Why Wider Strap Is Placed Inside of Boiler

On a butt and double-strap boiler joint why is the inside strap made wider than the outside strap? F. J. G.

In order to leave sufficient strength of the main shell plates between the rivet holes of the outside rows, the reaches between the rivets in those rows become too great to obtain a good calking edge unless the outer plates are very heavy, or else, to avoid the long calking distance, the edges of the plates are scalloped to conform to the diagonal pitches. Hence the outer strap usually is made no wider than necessary for obtaining the proper lap for an inner row of rivets, where the distance between rivets is short enough to afford a good calking pitch and a wider strap necessary for receiving the outer row of rivets, is placed on the inside of the boiler shell where calking is unnecesary.

Indicator Diagrams Show Wrong Valve Setting

We have a 16x15-in. Corliss engine direct-connected to a compressor, and the valves were set according to the marks by placing the wristplate on the central position when the steam valves were given ¼-in. lap and the exhaust valves ¼-in. lap; then the valve gear was hooked up to the eccentric and the eccentric shifted until there was ⅛-in. lead of the steam valves when the engine was on dead center. What would cause indicator diagrams to show compression only on the head end? M. P. T.

If the valve gear is symmetrical each side of the wristplate hub and the valves are properly connected, a difference of compression in opposite ends of the cylinder, after giving each exhaust valve the same amount of lap, would be due to improper adjustment in length of the eccentric rod, or reach rod, resulting in movement of the wristplate hook rod stud farther to one side of the central position than the other side. This, however, would have been true if both steam valves had the same lap and if approximately the same lead was obtained

when the engine was placed first on one center and then on the other. It must be concluded that the same lap and lead was not obtained for the steam valves or else, between the time of setting the valves and indicating the engine, there was a change in adjustment of the wristplate connections to the eccentric, or some other change in adjustment of the valve gear. See that the eccentric rod is of proper length to swing the rocker about as far to one side as the other side of a vertical position; then, with the wristplate hooked up, adjust the length of the wristplate hook rod to obtain movement of the central mark on the wristplate as far around from the central mark on the wristplate stud in one direction as the other, from turning the eccentric clear around on the shaft or from a complete revolution of the engine. Then with the wristplate in central position adjust the valve rods to give the desired amount of lap and, with the wristplate hooked up, place the engine on a center; turn the eccentric around on the shaft in the direction of rotation until the desired amount of lead is obtained for the valve that should admit steam for the beginning of a stroke and fasten the eccentric. If the adjustments have been made with care, inequalities of the leads or of compression shown by indicator diagrams can be rectified by adjustment of the valve rods.

U-Tube Gage for Indicating Depth of Tank Water

How can a mercury U-tube be arranged for approximately indicating the variations of water level in a tank that is 12 ft. deep and elevated 75 ft. above the ground?

W. A. J.

The general arrangement for such an altitude gage, constructed principally of iron pipe and fittings, is shown in the sketch. The mercury U-tube *ABCDE* is made of ½-in. pipe with the leg *AB* connected through the bottom of the tank by the pipe *RGH* and the leg *CDE* is extended upward with an open end to at least sufficient height for a column of mercury to balance the water pressure from the greatest head of water to be carried in the tank. Although the tank connections from *A* may be of any size of pipe, ¾-in. or larger pipe should be used to insure against the pipe becoming clogged with mud or other obstructions; but it would be preferable to have the mercury tube *ABCDE* made of ½-in. pipe throughout, and if an upper section *EF* is made of glass tubing it would be better to have this portion of the same bore as the pipes *AB* and *CDE*.

For determining the dimensions of the mercury U-tube, first establish the datum *LL* of 0 of elevation about 4 ft. above the ground.

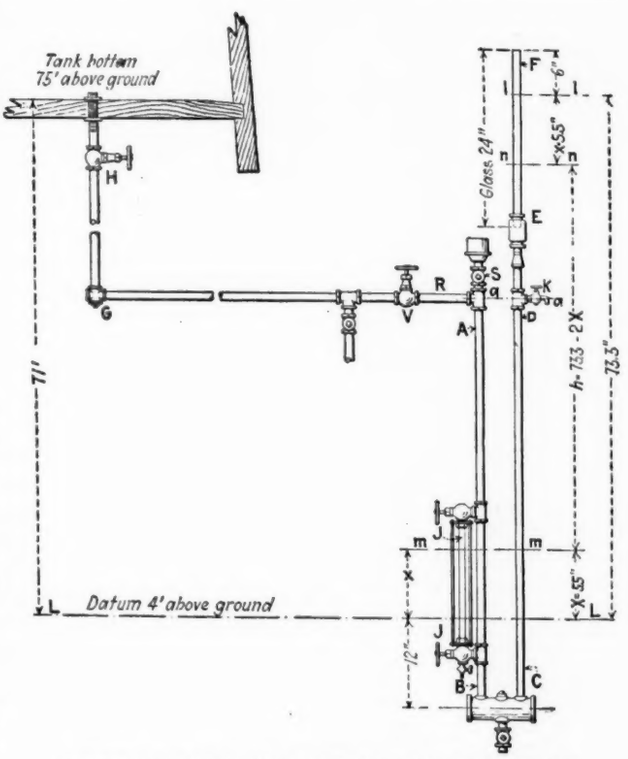
One inch of mercury column exerts a pressure equal to 1.132 ft. head of water, or 1 ft. of water = 0.883 in. of mercury column. Hence, if the highest water level has an elevation of (75 — 4) + 12 = 83 ft. above *LL*, the pressure exerted at the datum level would be balanced by a column of mercury 83 × 0.883 = 73.289 in., or about 73.3 in. high above *LL*. Having the upper end of *AB* and pet cock *K* one-half of 73.3, or 36.65 in. above *L*, then filling the U-tube *ABCD* with mercury to the level *aa* would supply the U-tube with sufficient mercury, after closing *K*, for a column 73.3 in. high in the leg *CE* above *LL* to balance the water column 83 ft. above *LL*, when admitted to the leg *AB* through the valve *V* after closing the stop cock *S*.

When the level of water in the tank is 12 ft. lower, the total elevation of the water column above *LL* would be 83 — 12 = 71 ft. But on account of less pressure of water acting on the surface of the mercury in *AB*, its level would rise to some higher elevation *mm* in *AB* and fall the same distance below *ll* in the leg *CDF*. Calling this distance x, the actual head of water would be 71 ft. — x in., or 852 in. — x in. = $\frac{852 - x}{12}$ ft., that would require a mercury column in the leg *CDE* above *mm* of $h = \left(\frac{852 - x}{12} \times 0.883\right)$ in. and this would be $2x$ shorter than 73.3 in., giving the equation

$$\frac{852 - x}{12} \times 0.883 = 73.3 - 2x,$$

or $x = 5.5$.

A glass gage *JJ* should be placed in the leg *AB*, as shown, to indicate the datum *LL* and the level *mm*, and it would be well to have the leg *CDE* terminate



MERCURY GAGE FOR INDICATING HEIGHT OF WATER IN TANK

within a glass tube *EE* extending about 6 in. higher than *ll* and joined about 6 in. lower than *nn*, the extremes of level obtained by actual tests with the tank filled to the highest and lowest levels. Scales applied to the glass gage *JJ* between levels *LL* and *mm* and glass tube *EF* between levels *LL* and *nn*, when calibrated for different depths of water in the tank, should closely correspond with each other in reading depths from *nn* upward and from *mm* downward. If the calibrations are made at the temperature of 62 deg. F., the divisions will be sufficiently accurate at other ordinary temperatures of the atmosphere.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Easy Lessons in Engineering

The A-B-C of Chemistry—I

This article and the one that follows will attempt to explain just enough of chemistry to serve as a foundation for the later study of combustion and other chemical processes found in power-plant work.

Although recent discoveries have shown that the *atom* is not the smallest unit of matter, it may be so considered for all practical purposes. An *element* is a substance containing only one kind of atom. Hydrogen is the lightest element of which we know. The *actual* weights of various atoms in ordinary units are not accurately known, nor would such weights have any particular practical value in every-day work. The *relutive* weights of various atoms are accurately known and of great practical importance. So the weight of the hydrogen atom is arbitrarily taken as "1." If another atom weighs 16 times as much, we say that its atomic weight is "16." This is the case with the gas oxygen.

A *molecule* is composed of two or more atoms. In the case of an element the molecule consists of two or more atoms of the same kind. The molecule of hydrogen gas, for example, contains two atoms of hydrogen and is represented by the symbol H_2, where H is the standard symbol for the hydrogen atom.

The accompanying table gives important data regarding those elements commonly met in power-plant chemistry. The standard symbols shown are abbreviations for the English or foreign names of the substances. The same abbreviations are used in all countries. *Molecular weights* are shown for the gaseous elements.

A *compound* is a substance where all the molecules are alike and where the molecules contain more than one kind of atom. A familiar compound is sulphuric acid. This is written H_2SO_4 and read "H, two, S, O, four." This *formula* shows that a molecule of sulphuric acid contains two atoms of hydrogen, one of sulphur and four of oxygen. Here, as in the case of any compound or element, the molecular weight is obtained by adding up the weights of all the atoms in the molecule. Referring to the table for the atomic weights, we see that the molecular weight of sulphuric acid must be:

$$1 \times 2 + 32 + 16 \times 4 = 2 + 32 + 64 = 98$$

When we mix hydrogen gas and oxygen gas, say in the proportion of two parts by weight of hydrogen to sixteen parts of oxygen, the product is a *mixture*, not a compound, because it contains two different kinds of molecules. If this mixture is ignited, there is a very rapid *chemical change* (visible as an explosion), and the atoms of hydrogen break away from their original elementary molecules and rush together to form molecules of water (H_2O), a true compound.

However a chemical change may affect the molecules and the resulting properties, two things remain unchanged. One is the total weight and the other the total number of each kind of atom. This is the most fundamental conception of chemical science, and is known as the law of conservation of mass.

The *chemical change* that takes place whenever the arrangement of atoms within the molecules is changed may be stated in the abbreviated form of a *chemical equation*. For example, the explosive combination just mentioned, of hydrogen and oxygen to form water may be written; $2H_2 + O_2 \rightarrow 2H_2O$. This says that two molecules of hydrogen, containing two atoms each, combine under proper conditions with one molecule of oxygen, containing two atoms, to form two molecules of water, each of which contains two atoms of hydrogen and one of oxygen. Note that there are the same number of hydrogen and oxygen atoms present before and after the reaction (four of hydrogen and two of oxygen). It follows that no weight is lost or gained by the reaction. This may be checked by rewriting the equation with the corresponding weights below each formula as follows:

$$\begin{array}{ccccc} 2\ H_2 & + & O_2 & \rightarrow & 2\ H_2O \\ 2\ (1 \times 2) & + & 16 \times 2 & \rightarrow & 2\ (1 \times 2 + 16) \\ 4 & + & 32 & \rightarrow & 36 \end{array}$$

Where all the substances taking part in a chemical reaction, and all those resulting, are known, the first step in forming the equation is to write down the formulas for the various molecules on the proper sides of the equation. The next step is to find the proper number of each kind of molecule to make the number of each kind of atom the same on the two sides of the equation.

The equation having once been balanced, it is a simple matter to figure the weights of the various substances. For example, by working from the atomic weights we found that four parts by weight of hydrogen combined with 32 parts of oxygen to form 36 parts of water. We know that both sides of an equation may be divided by the same number without destroying the equality. This permits of writing this weight relation in the following ways:

4 parts hydrogen + 32 parts oxygen produce 36 parts water

1 lb. hydrogen + 8 lb. oxygen produce 9 lb. water

$\frac{1}{8}$ lb. hydrogen + 1 lb. oxygen produce $\frac{9}{8}$ lb. water

$\frac{1}{9}$ lb. hydrogen + $\frac{8}{9}$ lb. oxygen produce 1 lb. water

TABLE OF COMMON ELEMENTS

Name	Symbol	Atomic Weight	Kind of Element	Common State	Molecular Formula	Molecular Weight
Aluminum	Al	27.1	Metal	Solid	..	..
Calcium	Ca	40.1	Metal	Solid	..	..
Carbon	C	12	Non met.	Solid	..	..
Chlorine	Cl	35.5	Non met.	Gas	Cl_2	71
Copper	Cu	63.6	Metal	Solid	..	..
Hydrogen	H	1	Non met.	Gas	H_2	2
Iron	Fe	55.8	Metal	Solid	..	..
Lead	Pb	207.2	Metal	Solid	..	..
Magnesium	Mg	24.3	Metal	Solid	..	..
Nitrogen	N	14	Non met.	Gas	N_2	28
Oxygen	O	16	Non met.	Gas	O_2	32
Potassium	K	39.1	Metal	Solid	..	..
Silicon	Si.	28.3	Non met.	Solid	..	..
Sodium	Na	23	Metal	Solid	..	..
Sulphur	S	32	Non met.	Solid	..	..
Tin	Sn	118.7	Metal	Solid	..	..
Zinc	Zn	65.4	Metal	Solid	..	..

Effect of Temperature on Properties of Steel

Some valuable findings on the effect of temperature, deformation and rate of loading on the tensile properties of low-carbon steel below the thermal critical range, are given in Technologic Paper No. 219, prepared by H. J. French, physicist with the Bureau of Standards. The following abstract covers certain portions that are particularly applicable to the power-plant field.

The steels tested in this investigation were received as half-inch boiler plate of firebox and marine grades. They were made in the basic open-hearth furnace, and the baths kept in a boiling condition up to the moment of casting.

The apparatus available permitted the testing of the pieces in tension, either at room temperature or heated to any desired higher temperature by means of an electrically heated furnace surrounding the specimens. Tests at each temperature were made in duplicate or triplicate, and the proportional limit was obtained from a stress-strain diagram, this limit being the point at which the curve begins to fall away from the straight line.

Fig. 1 shows the effect of temperature upon the tensile strength of "American Society of Testing Materials" firebox boiler plate at elevated temperatures. This steel had a tensile strength running from 52,000 to 62,000 lb. per sq.in., and had the following composition: Carbon, 0.19; manganese, 0.43; phosphorus, 0.020; sulphur, 0.031 per cent. It will be noticed that the average tensile strength starting around 59,000 lb. at 70 deg. F., decreased slightly up to 200 deg. and then increased considerably to a maximum of 66,000 lb. at 560 deg. Beyond this there was a rapid fall to 42,000 lb. at 860 deg.

The reduction in area, as might have been expected, varied at all times in the opposite direction from the tensile strength. The elongation in two inches followed the general course of the reduction in area. Probably more important than the tensile strength is the proportional limit, as shown by the lower curve. This reached its maximum at a lower temperature than the tensile strength and fell to 12,000 lb. at 850 deg., as compared with 24,000 lb. at

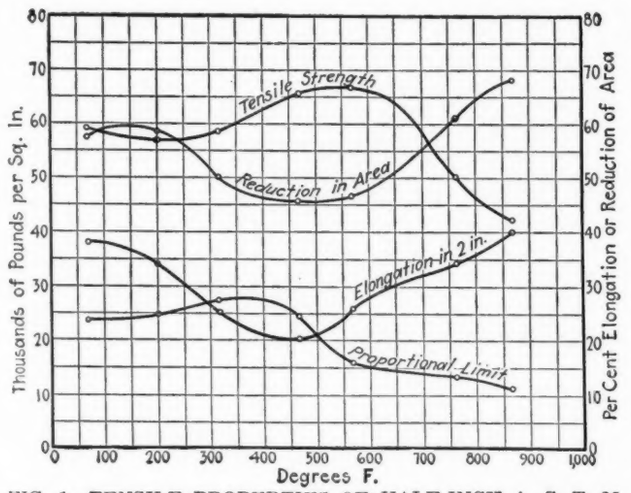


FIG. 1—TENSILE PROPERTIES OF HALF-INCH A. S. T. M. FIREBOX BOILER PLATE AT ELEVATED TEMPERATURES.

room temperature. These tests were made on the plate as rolled.

Fig. 2 shows similar tests made on cold-rolled steel of the same composition, the plates having been reduced cold from ½ in. to 7/16 in. in thickness. By comparing these curves with those in Fig. 1, it is seen that this amount of cold reduction (12.5 per cent) increases the tensile strength at room temperature about 20 per cent. It also increases the strength of the hot-rolled plates up to about 870 deg. F., by a similar amount, showing that this effect is maintained until relatively high temperatures are reached.

The changes in proportional limit are more marked and of considerable interest. At ordinary temperatures an increase of about 80 to 95 per cent is shown. Similarly, an increase of 60 to 100 per cent above the values obtained in hot-rolled plates is found at temperatures up to and including 470 deg. In the blue-heat range (565 deg. F.) the increase in proportional limit, due to cold working, reaches the very high value of 200 per cent in the firebox grade. This, however, is not accomplished at the expense of ductility.

In order to determine whether these changes at blue heat are maintained at ordinary temperatures, specimens were annealed at successively increasing temperatures and

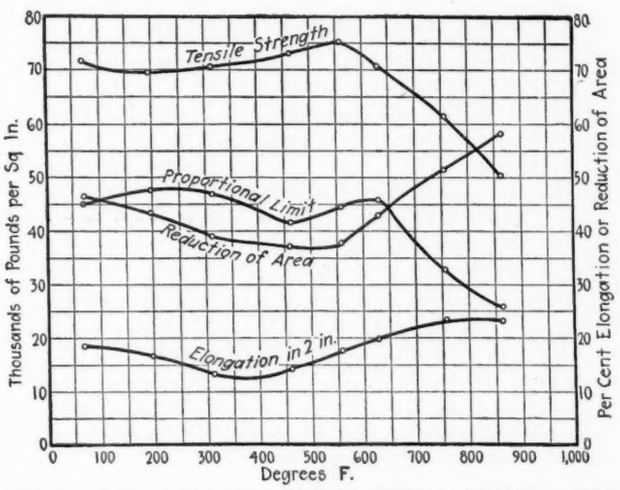


FIG. 2—SAME AS FIG. 1, EXCEPT STEEL, REDUCED COLD FROM HALF-INCH TO SEVEN-SIXTEENTHS.

then tested in the usual manner, at the temperature of the room. These tests showed that short-time annealing in the blue-heat range has little effect on the tensile strength and elongation, but materially increases the elastic ratio, with only a minor decrease in reduction of area. In the case of the firebox steel under test, this increase in the limit of proportionality is about 20 per cent. The test also showed that a short-time annealing at a somewhat higher temperature (765 deg. F.) accomplishes little, if anything, in the improvement of the tensile properties of this cold-rolled steel.

If cold-rolled steel is heated for a short time at blue heat and then cooled, the result is a decided elevation of the limit of proportionality with no material change in tensile strength or lowering of ductility. This is of practical interest in the production of such material as cold-drawn light-wall tubing, where "bluing" after the last cold pass will improve the tensile qualities.

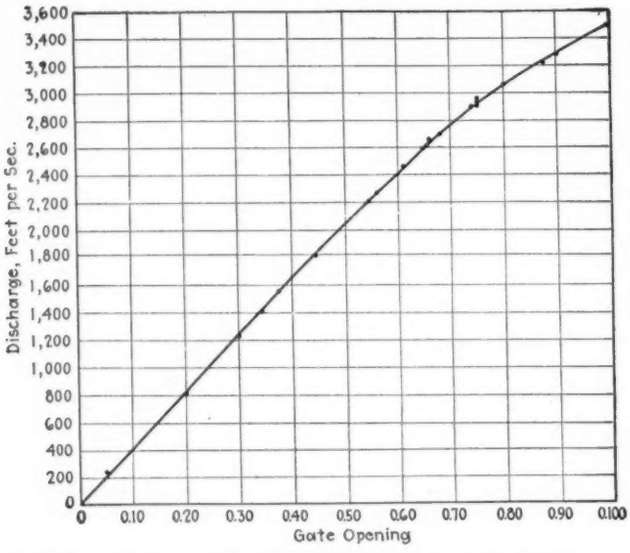
Reduction in thickness of 6¼ per cent at blue heat produces about the same increase in strength at temperatures up to and including 565 deg., as twice this cold reduction. Above blue heat the strength of the cold-rolled steel is slightly in excess of that blue rolled, though the general shape of the tensile properties temperature curve, for both conditions mentioned, is the same.

Blue work (6.25 per cent reduction in plate thickness) is more effective in raising the limit of proportionality of low-carbon steel at temperatures below the blue-heat range than twice this work in the cold, but at blue heat the increase in this factor is much greater in the cold-worked metal. At higher temperatures the increase produced by both methods of working is approximately the same.

While longitudinal and transverse tensile tests do not wholly define the character of the metal, sufficient evidence is presented to show the extreme susceptibility of the steel to deformation in the blue-heat range, and for that reason alone, such working should be avoided. There is, however, little or no evidence to prove that a limited amount of blue work permanently injures the metal. For, as pointed out by Howe and here substantiated by the author, restoration of ductility may be obtained by annealing.

Salt-Velocity Method of Measuring Water*

The salt-velocity method of measuring water consists of accurately timing the passage of a charge of brine between two or more known points, which has been injected into the stream flow. By dividing the volume of conduit (cu.ft.) between these points by the time of passage (in seconds) the rate of flow (cu.ft. per sec.) is obtained. The conductivity of water varies directly as its salt content. The brine is usually introduced under air pressure through a piping system designed to give approximately uniform dis-



CURVE SHOWING CONSISTENCY OF MEASUREMENTS OF DISCHARGE BY SALT-VELOCITY METHOD.

tribution. The timing of the passage of charge is made by means of a stop watch or recording seconds clock and indicating electrical instruments, or recording electrical instruments such as ammeter, voltmeter, wattmeter or watt-hour meter.

The time of introduction may be registered by a switch operated in conjunction with a quick-opening brine-introduction valve or by a pair of electrodes located just below the brine distributing system. The time of passage by the lower points or sections of conduit is obtained by the use of one or more pairs of electrodes, either installed in the conduit or inserted through stuffing boxes. By means of properly designed electrodes complete traverses of the conduit can be made if desired.

The recording chart can be run at various predetermined speeds to suit best the conditions of test. All events can be registered mechanically or electrically on this chart, such as introduction of brine, passage of brine by one or more sets of electrodes, seconds, revolution of wheel shaft, etc.

From these charts the actual time of brine passage is obtained. So far as investigations have been made, the true time is shown, or mean velocity through conduit is given by the center of gravity of the area recorded on the chart by the charge. In pipe lines of sufficient length the time of the center of gravity of the charge coincides with the time of its maximum conductivity.

This method can be compared with the submerged float method as used in canals of uniform cross-section. In the salt-velocity method there is almost an infinite number of truly submerged floats instead of a few. With all of the events recorded automatically on the chart, personal errors are eliminated and all electrical calibration of instruments made unnecessary. Comparative tests of this method with the Venturi meter, weir and weighing tank show it to be an accurate means of measuring large or small volumes of water.

Field tests of a waterwheel have recently been made where quantities as high as 3,500 cu.ft.-sec. where measured. The discharge curve of this wheel, given in the figure, shows the consistency of the measurements. The penstock was 20 ft. in diameter, and the electrodes were approximately 500 ft. apart. In one plant where the available length of rectangular penstock was about 55 ft., something over 2,000 individual shots of brine, or tests, were made to investigate this method. During these investigations a remarkable consistency of results was noted. Tests could be repeated day after day and made to check.

*Abstract from N.E.L.A., 1923, Hydraulic Power Report.

Size of Pulverized Coal

There is no definite size to which coal must be ground for use in powdered-coal burning plants, although it is recommended, generally, that 95 per cent of the pulverized coal should pass through a sieve with 100 meshes to the inch and 80 to 85 per cent through a sieve with 200 meshes to the inch, states John Blizard, fuel engineer of the Department of the Interior in Bulletin 217, just issued by the Bureau of Mines.

It has been found possible to operate some furnaces with coarser coal, and found necessary for firing open-hearth furnaces to grind the coal more finely. The more finely the coal is ground, the more rapidly will it burn and the more readily will the smaller ash particles pass off with the gas. The power required to pulverize coal increases, however, with the fineness of pulverization.

Fewer Boiler Explosions in Europe*

A comparison of the number of boiler explosions shows that greater safety in operation prevails in Europe. For every 10,000 boilers in service there are eleven times as many explosions in the United States as in Germany. Statistics were obtained for the United States, Great Britain, France and Germany, based on reports by the Hartford

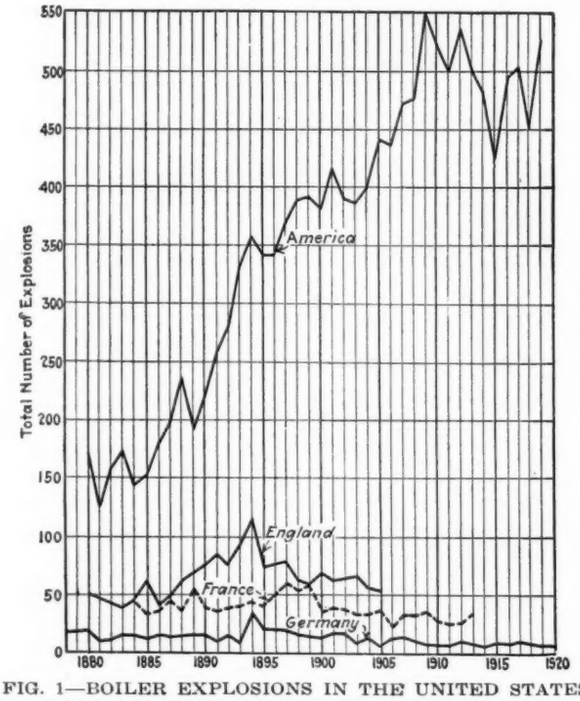


FIG. 1—BOILER EXPLOSIONS IN THE UNITED STATES, GREAT BRITAIN, FRANCE AND GERMANY FOR THE PERIOD FROM 1880 TO 1920

Steam Boiler Inspection and Insurance Co., the author's records, the *Statistique de l'Industrie Minerale* and German government reports.

The total number of boiler explosions in the respective countries is graphically shown by the curves in Fig. 1. The peak in the curves which appears for the year 1894 is due to a change in the definition as to what constitutes a boiler explosion. The former basis was restored the following

*Abstract of an article in the April issue of *Stahl und Eisen*.

year, as a result of a protest filed by the engineering profession.

The value of the curves is diminished by the fact that the number of boilers in actual service is not stated. This information was obtainable only for Germany and in this case only for three years. In 1879 there were 60,000 boilers. This figure increased to 140,000 in 1899, and in 1913 the number reached 170,000. For the other countries it was assumed that the number of boilers increased in approxi-

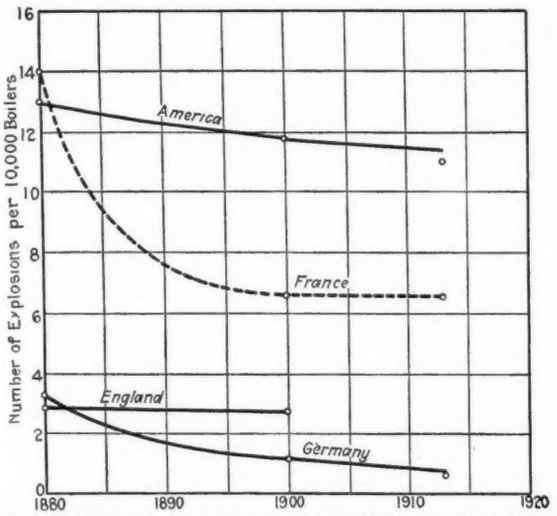


FIG. 2—NUMBER OF BOILER EXPLOSIONS FOR EVERY 10,000 BOILERS IN OPERATION IN THE UNITED STATES, ENGLAND AND FRANCE AND GERMANY FROM 1880 TO 1913

mate proportion to their coal and pig-iron production. This assumption cannot be allowed any degree of accuracy, but it does serve to give a rough idea of the relative safety of boiler operation in the countries that are represented.

Fig. 2 shows the number of boiler explosions for every 10,000 boilers installed. The curves show that boiler explosions were far less common in Germany and England than in the United States and France during the period given. In all cases they indicate the beneficial effect of boiler regulations and better care exercised in operating boilers. The lesson to be learned is that further developments along this line should not be neglected.

[It should be noted that the curves for America are based on fragmentary statistics and have no value as an exact record. At the same time they do illustrate clearly the well-known fact that America is far behind England and Germany in the matter of boiler safety.—EDITOR.]

The Internal-Combustion Turbine

From time to time during the last twenty years or more, *Engineering* (London) states, the question has arisen as to whether a turbine working on an internal-combustion cycle is a practicable proposition. The question that requires consideration is not whether it is possible to construct a reliable working machine—that may be taken for granted if the matter is left in the hands of competent designers—but whether the efficiency which recent designs appear to offer, is sufficient to bring the gas turbine into the market as a practical and economical prime mover.

An over-all thermal efficiency, that is, the ratio of heat equivalent of effective work to heat units supplied—of from 25 to 28 per cent appears to be about the practical limit of what can be accomplished today in internal-combustion turbine design. This limit is imposed by the fact that the temperatures of the working fluid are such that the strength of the materials of construction, and particularly that of the rotor wheel, which is necessarily the most highly stressed portion in a turbine, is very considerably reduced. But while higher mechanical efficiency is not likely to be obtained until great improvements in the heat-resisting qualities of material are made, comparatively small advances will gradually enable cycles of higher absolute thermal efficiencies to be utilized. Thereby a direct step-by-step improvement in the over-all efficiency will carry us forward until such time as a better rotor and blade material will admit of the use of single-row wheels in lieu of the inherently less-efficient velocity-compounded wheel. These small advances may be made either in the way of a higher impinging temperature or of higher blade velocity or of both.

For the temperatures necessary for efficient gas-turbine working, we must look in the direction of composite steel alloys. Chromium, tungsten, vanadium and molybdenum have all been experimentally used, but the results nearly all require further research before their reliability can be accepted as adequate for gas-turbine rotors. Some of the alloys are difficult to work, others tend to develop cracks after a time, and it must be remembered that compared with steam turbines the danger of setting up undue internal strains when starting up or shutting down is very much magnified in the internal-combustion turbine. Neither in constructional features nor in the problem of attaining high efficiency is the gas turbine a simple matter. The field that would apparently be open to a satisfactory solution seems to be a very wide one, and much of its importance lies in the influences that it may bring to bear in other directions.

With the exception, perhaps, of the Holzwarth constant-volume oil combustion turbine, ordered by the Prussian State Railways, which was, until recently, running at the Thyssen Works at Mulheim, Germany, there is probably no practical gas turbine in operation today. To assume, therefore, that it is an existing type of engine is, to say the least, distinctly stretching actual facts in its favor. On the other hand, to disparage its possibilities, even with present material and experience, would be very rash in view of the rapidity and extent of development that took place in the case of the steam turbine between one and two decades ago. The rôle which the internal-combustion turbine could or might fill requires thorough consideration before any attempt should be made to judge of its future, to condemn which, merely on account of past failures, does scant justice to the subsequent growth of knowledge and improvements in material. To regard the turbine as a potential competitor of the oil engine, and still more to repudiate its prospects on account of the exceptional economy obtained by the latter, is to take far too narrow a view of the functions that the gas turbine may eventually prove able to undertake without encroaching on existing types for many a year to come. It is undoubtedly with the steam engine (or turbine) and its boiler and condensing plant that the gas turbine will prove a formidable competitor, and it has a long road to travel before this really becomes of serious commercial importance.

Lower Freight Rate Sought for Boiler Compounds

The fourth-class freight rating of boiler preservatives, compounds and boiler-metal treatments or scale-removing compounds, in official classification territory, is unreasonable, in the opinion of Interstate Commerce Commission Examiners C. I. Kephart and F. N. Oliver. In a report to the Commission they recommend a fifth-class rating, with a minimum of 36,000 lb. to the carload. This is an outcome of the attack made on this rate by the Garratt-Callahan Co., of Chicago. The basic ingredient in these compounds is sodium silicate. The lesser component parts are not stated, since they are trade secrets. These preparations, which are liquid, are shipped in barrels, kegs, and drums. They are harmless to metals or fabrics and are non-inflammable and non-freezable. The sale prices range from 60c. to $1 a gallon. Losses in transit are negligible.

The complainants point out that these compounds differ from water softeners, which chemically purify the water to prevent scale or cause precipitation of impurities, in that they are mixed with the feed water as it enters the boiler. reach the hot metal, expand and force from the boiler shell the scale deposited by impurities in the water.

News in the Field of Power

Governor Pinchot's Power Bill Passed Pennsylvania's Legislature

Giant Power Survey Board Created To Co-ordinate Water and Fuel Resources

GOVERNOR PINCHOT'S program of power legislation for Pennsylvania was completed by the passage of the general power bill and the companion condemnation bill on the last day of the legislative session. It included the preparation of sound and farseeing plans for the future as well as provision for present needs.

Most significant for the future is the Act of May 24 (No. 240) creating a Giant Power Survey Board (Governor, Attorney General, Secretary of Forests and Waters, Chairman of the Public Service Commission, Secretary of Agriculture, Secretary of Labor and Industry, State Geologist, a Deputy Attorney General and an engineer to be appointed by the Governor). This board is to make an outline survey of the power resources available for the supply of Pennsylvania's needs and will recommend a policy to be embodied in legislation by the General Assembly convening in January, 1925. The end in view is the most efficient development of the state's great fuel power resources, supplemented by water power, the pouring of the general output of these fuel and water-power resources into a common reservoir of interconnected transmission lines covering the Northeastern States, and the service of the industries, farms and homes of Pennsylvania from this common reservoir. The possibilities and advantages of locating giant power plants at the coal mines, saving the byproducts of coal now wasted in fuel power plants, electrifying railroads, and co-ordinating flood prevention and stream purification, so far as practicable, with water-power development, are to be investigated.

Related to the Giant Power Survey Act is the act of the same date (No. 239) authorizing the Governor to designate three officers of the Commonwealth to negotiate with New York and New Jersey a compact for the regulation of the Delaware River and the apportionment of its waters. New York and New Jersey have passed similar statutes carrying appropriations for surveys and plans.

The complete regularization of the Delaware (by storage of the whole flow, thus preventing floods) will develop an estimated 400,000 hp. New York City desires to begin in 1935 to draw upon the upper Delaware for its municipal supply, and such complete regularization will, by abolishing periods of low water, simplify the purification problem for Pennsylvania cities taking water from the river.

Present needs are met by the Act of June 14 (No. 294) regulating future permits granted by the Water Supply Commission (transformed by the Administrative Code into the Water and Power Resources Board in the Department of Forest and Waters) for dams and changes in streams to develop water power, and to store, cool, divert and use water for steam raising and steam condensation in the generation of electric energy for use in public service.

As to all such future permits the principles of the Federal Water Power Act are to be applied. If the waters concerned are under federal jurisdiction, the state permit will be contingent upon the permittee's obtaining a federal license, the conditions of which may be enforced by the Commonwealth if and to the extent that the federal government is unable to enforce them or waives them. Among these conditions are: A maximum time limit of fifty years with extensions and renewals until the net investment is repaid by a new licensee or by the United States; a requirement of full and prompt development; an obligation to contribute to the cost of upstream storage reservoirs in proportion to the benefits derived from them through increased power capacity during periods of low water; the fixing of the net investment (cost prudently incurred) as the basis of rate regulation, and of the issue of securities; and the expropriation to the public of profits in excess of a reasonable return on the net investment, this either in the form of the amortization of the net investment or in the form of annual rent paid to the United States.

If the waters concerned are not within the jurisdiction of the United States, the Act fixes a maximum time limit of fifty years with extensions and renewals until the capital prudently invested on the faith of the permit has been repaid by the Commonwealth or by a new permittee, and gives broad powers to enable the state to impose conditions like those in a federal license. A system of fees will be established to pay the cost of administering the act. The right to flood islands owned by the Commonwealth, hitherto inalienable, may be granted by the board.

The companion Act of the same date (No. 293) restores to public service companies holding permits under Act No. 294 the right to condemn waters and lands under water, which was taken away by the Pennypacker Act of 1905; their condemnation rights are enlarged in other respects and they may flood, relocate and reconstruct highways, bridges and railroads. The exercise of all these powers is to be controlled at every step by the board. Water-supply projects, as well as power projects, are included within these bills, but the privilege of flooding islands owned by the Commonwealth is not extended to water-supply projects nor is their tenure limited to fifty years.

Two other Acts authorize the Department of Forests and Waters to lease for periods not to exceed fifty years (Act of May 28, No. 250) and to grant easements in state forest lands for water-supply projects (Act of May 21, No. 186) without limit of time.

Western Society of Engineers Hold Annual Dinner

At the Hamilton Club, Chicago, on June 18, the Western Society of Engineers held its fifty-third annual meeting and dinner, with an attendance approximating 250. Homer E. Niesz, acting in the capacity of toastmaster, called first upon Julius L. Hecht, retiring president, who reviewed the activities of the society for the last year, one of the most successful in the society's career. The new president, Charles A. Morse, chief engineer of the Chicago, Rock Island & Pacific R.R., pointed out that the average ability of the 2,500 men in the society was greater than that of any political body in the country when it came to the discussion of questions relating to the expenditure of money for public improvements. A society like the Western, whose membership is entirely voluntary, owing no allegiance to any party or corporation, can do a great good for the community at large by going into all matters of proposed public improvements and into the operation and maintenance of those already made, keeping the public posted regarding waste of money and calling attention to opportunities to make a saving. In this way the work of the Western Society of Engineers will become so well known and so interesting that every engineer in the country will be anxious to become a member and every public body and the general public will have confidence in the honesty

and integrity of its reports and recommendations.

E. Hill Leith, of Halsey Stuart & Co., bankers, spoke on the subject "The Financier and the Engineer." Mr. Leith emphasized the necessity for closer relations and a better understanding between the engineers who design and build plants, for which securities must be sold, and the bankers or financiers who have to handle these securities. There should be some common meeting place where the two interests can meet and interchange ideas. In finance there is nothing mysterious, it is largely a matter of common sense.

A feature of the evening was the presentation of the Washington Award to Robert Woolston Hunt, past president of the Society, for "His pioneer work in the development of the steel industry and for a life devoted to the advancement of the engineering profession." W. L. Abbott, chairman of the Washington Award Commission, presented Mr. Hunt with an inscribed tablet bearing the foregoing quotation. It will be remembered that this is an annual recognition of the American whose work has been of the greatest benefit to the country, founded in 1916 by John W. Alvord. Herbert Hoover, secretary of commerce, was given the award last year.

Officers elected for the coming year are: C. A. Morse, president; E. T. Howson, first vice-president; Horace Carpenter, second vice-president; H. H. Clark, third vice-president; George W. Hand, treasurer; E. W. Allen, John A. Dailey and M. M. Fowler, trustees.

Quebec May Double Royalties on Power Leaving Province

According to the *Canadian Engineer*, Premier Tashereau of Quebec, in speaking before the board of trade at Three Rivers, pointed out the importance of the development of water power, and made it clear that despite sisterly affection for other provinces, the government would double the royalty on the production of horsepower on all power going out of the province, whether to other provinces or to the United States.

F. M. Feiker to be with Society of Electrical Development

F. M. Feiker, formerly vice-president of the McGraw-Hill Company, Inc., and more recently on leave of absence as special agent to the Department of Commerce at Washington, will after his return from Washington, be associated with the staff of the Society for Electrical Development, 522 Fifth Avenue, New York City. As a result of the appointment of Mr. Feiker, the various branches of the electrical industry served by the society will secure the benefit of his broad experience and background, for he will be available to act as a special counselor to engineers, manufacturers, central stations, jobbers, contractor-dealers and publishers, and his special training and wide knowledge in the engineering publishing and public relation fields of many industries qualify him eminently for such consulting work. Mr. Feiker will retain a consulting relation to the McGraw-Hill Company, Inc., and he will continue in a similar capacity his relation to the problems of personnel and organization of the Department of Commerce at Washington.

Dual Temperature Rating for Electric Motors Rescinded

At a recent meeting of the Electric Power Club the two temperature-rating standards were recinded and in their place was adopted as "recommended practice" a 40-deg. rating without an overload guarantee. The formal statement of the board of governors on the new recommendations are as follows:

"The Electric Power Club has rescinded its two 'Adopted Temperature Rating Standards' on general-purpose motors:

"(1) The 50-deg. motor without overload guarantee, and

"(2) The 40-deg. motor with 25 per cent overload guarantee for two hours; and has approved as 'recommended practice' the following:

"'(a) An open-type general-purpose motor shall be capable of carrying full rated load continuously with a temperature rise not exceeding 40 deg. C.

"'Note.—Such a motor should be so designed as to be capable of carrying sustained overloads (in no event exceeding 50 per cent overload) within a temperature of 90 deg. C. (measured by thermometer).

"'(b) That it is the sense of the Electric Power Club at this time that general commercial practice of the ensuing year will probably lead to the unanimous support of the club to the adoption of a single-rating temperature standard for general-purpose motors without overload reference of any character.

"'(c) That within a year the "recommended practice" referred to in paragraph (a) be submitted to the Electric Power Club for vote as an "adopted standard."'"

Anthracite Report of the President's Coal Commission to Be Out July 1

Will Take Up Nationalization of Coal Mines and Valuation of Coal Properties

VIGOROUS expression of views in the matter of nationalizing coal mines may be expected in the anthracite report to be made July 1 by the President's Coal Commission. Chairman Hammond, of the Commission, stated recently that the report will contain a discussion of the whole subject of nationalization. Another pronouncement, expected in the report, will deal with the evaluating coal properties.

The coal operators contend that the only equitable method of establishing valuation would be on the present market value of the properties. They deny that original cost is of value in determining present worth. To support that contention, it is pointed out that an operator who has come recently into the business would have to have his valuation established on present market price, whereas an old established adjacent concern producing the same quality of coal under the same conditions would have his valuation based on original cost. The operators also are opposed to the Treasury method of valuation, wherein the 1913 value plus actual additions since, is used.

It is very evident that the Commission cannot undertake careful evaluation of coal mines after the fashion of public-service commissions in the case of public utilities. To undertake this would require years of time and not less than $2,000,000 in money. It is believed, however, that the Commission will have something very interesting to say as to methods of evaluating which best can be applied to coal mines. Incidentally, any recommendations on that subject will be of great interest to those concerned with the resources, of which there is only one crop available.

Unquestionably the Commission is giving close attention to the Supreme Court's decision in the Kansas Industrial Court case, in which a distinction is drawn between the mining of coal and the services coming under the head of public utilities. The decision also is certain to be considered by the Commission with respect to its bearing on the settlement of disputes between employer and employee. The Court's position that the fixing of wages by a tribunal with compulsory powers is a denial of freedom of contract under the Fourteenth Amendment to the Constitution is certain to have a bearing on what the Commission may say in regard to improving the present conciliation machinery in the anthracite region. Apparently, the Supreme Court has shut the door to any possibility of requiring operators and miners to submit a dispute to compulsory arbitration unless the Commission should take the position that the production of coal is a public-utility industry.

All the fundamental data on which the anthracite report will be based were in hand on June 15. That the documents are very voluminous may be judged from Mr. Hammond's statement to the effect that they cover 200 square feet of varying depths. All the data on which conclusions will be based are to be made public. Proper safeguards will be employed to protect legitimate business secrets. Since some arrangement and summarization will be necessary to make this information readily understandable, it is probable that it will be released periodically following the issuance of the report itself.

Install Electric Steam Boiler of 18,000 Kw. Capacity

There has just been completed, for the Brown Co., Berlin, N. H., an installation of an electric steam boiler of 18,000-kw. capacity, operating at 22,000 volts, on three phase, 60 cycle current with steam pressure of 135 lb. gage. The boiler consists of three single-phase tanks. This is one of the first boilers of so high a voltage that has been attempted, and the results obtained are commensurate with the expectations entertained by the companies concerned. The Electric Furnace Construction Co., of Philadelphia, Pa., built and installed this equipment.

Will Demonstrate Correct Compound for Engines

At the National Exposition of Chemical Industries during the week of Sept. 17-22 a huge buying fair will be held, each exhibitor to display his goods in a novel manner so as to demonstrate its peculiar characteristics, special uses and selling points. The results of research on a scientifically correct anti-knock and carbon compound for internal-combustion engines will be demonstrated.

Society Affairs

The **Station Operating Committee** will present its annual report to the Ohio Electric Light Association at its convention at Cedar Point, Ohio, July 10-13.

The Brooklyn Engineers' Club has recently elected as president L. S. Stiles. The club is 28 years old and has enrolled many members who have been prominent in public engineering projects in New York City.

Personal Mention

David B. Rushmore, consulting engineer, of Schenectady, has just been given the D.S. degree by his alma mater, Swarthmore College.

Dr. S. W. Stratton, formerly director of the Bureau of Standards, was inaugurated as president of the Massachusetts Institute of Technology on June 11.

Julian C. Smith, chief engineer of the Shawinigan Water & Power Co., has had conferred upon him the degree of L.L.D. by Queen's University, Kingston, Ontario.

John T. Sharp, Jr., has tendered his resignation as superintendent of the Canton Light & Water Works Plant, at Canton, Miss., to accept a position as manager of the Helena (Ark.) Gas & Electric Company.

Chester C. Dodge has entered the electrical engineering division of Stone & Webster, Inc., in the Boston office. He was formerly in the marine engineering department of the General Electric Co., at Schenectady.

Coming Conventions

American Institute of Electrical Engineers; F. L. Hutchinson, 29 West 39th St., New York City. Summer Convention at Swampscott, Mass., June 25-29.

American Institute of Electrical Engineers, F. L. Hutchinson, 29 West 39th St., New York City. Pacific Coast Convention at Del Monte, Calif., Oct. 2-5.

American Institute of Mining and Metallurgical Engineers; F. F. Sharpless, 29 West 39th St., New York City. Annual meeting at Ontario, Quebec, Canada, Aug. 20-31.

American Society for Testing Materials; C. L. Warwick, 1315 Spruce St., Philadelphia, Penn. Annual meeting at Atlantic City, N. J., June 25-30.

American Society of Civil Engineers; J. H. Dunlap, 33 West 39th St., New York City. Annual Convention at Chicago, July 11-13.

Association of Iron & Steel Electrical Engineers; J. F. Kelly, 1007 Empire Bldg., Pittsburgh, Pa. Iron and Steel Exposition at Buffalo, N. Y., Sept. 24-28.

American Society of Refrigerating Engineers, William H. Ross, 35 Warren St., New York City. Nineteenth Annual Convention at New York City, Dec. 3-5.

Canadian Association of Stationary Engineers; Gordon C. Keith, 51, Wellington St. West, Toronto, Canada. 34th Annual Convention at Toronto, Canada, June 25-28.

International Union of Steam and Operating Engineers; Dave Evans, 6334, Yale Ave., Chicago, Ill. Annual convention at Detroit, Sept. 10-15.

National Association of Practical Refrigerating Engineers; Ed. H. Fox, 914-25 East Jackson Blvd., Chicago. Fourteenth Annual Convention at Memphis, Dec. 12-16.

National Association of Stationary Engineers; Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Buffalo, N. Y., Sept. 10-15. Annual conventions and exhibitions of the State Associations scheduled as follows: **Michigan** at Flint, July 18-20. E. C. Smith, 308 Vine St., Kalamazoo, Mich. **New England States Association**, at Manchester, N. H., Manchester hotel, July 12-14; Freeman L. Tyler, 32 Briggs St., Taunton, Mass. **Pennsylvania**, at Buffalo, Sept. 9-10; J. N. Calvert, Crafton Sta., Pittsburgh, Pa. **New York**, at Buffalo, Sept. 9-10; W. T. Meinzer, Third St., near Warburton, Bayside, L. I., N. Y. **Minnesota**, at Duluth, Aug. 8-10; C. A. Nelson, 800 22d Ave. N. E., Minneapolis. **Connecticut**, at Waterbury, June 29-30; L. Van Der Eyk, 251 Wood St., Waterbury.

National Safety Council, W. H. Cameron, 168 North Michigan Ave., Chicago, Ill. Twelfth annual congress at the New Statler Hotel, Buffalo, N. Y., Oct. 1-5.

New England Association of Commercial Engineers; James F. Morgan, 53 Devonshire St., Boston, Mass. Power Show at Mechanics Bldg., Boston, Mass., Oct. 29-Nov. 3.

The New England Water Works Association; Frank J. Gifford, 715 Tremont Temple, Boston, Mass. Annual Convention at Burlington, Vermont, Sept. 18-21.

National Exposition of Power and Mechanical Engineering; Charles F. Roth, Room 1102, Grand Central Palace, New York City. Power Show, Dec. 3-8.

Ohio Electric Light Association, D. L. Gaskill, Greenville, Ohio. Annual convention at Cedar Point, Ohio, July 10-13.

Society of Naval Architects and Marine Engineers, Daniel H. Cox, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 8-9.

Universal Craftsman Council of Engineers; John F. Amos, P. O. Box 299, Rochester, N. Y. Convention at Rochester, N. Y., Aug. 7-11.

Business Notes

The **Dingle-Clark Co.**, contracting engineers, of Cleveland, Ohio, announce the opening of a Pittsburgh, Pa., office at 311 Ross St., in charge of H. M. Leathers, who has been with the company a number of years.

The United Conveyor Co. will be represented in the Chicago district, by J. W. Himmelsbach, president of the H. E. Supply Co., 511 Monadnock Bldg., in the handling of sales of steam-jet ash conveyors and tile ash hoppers.

Bolinders Company, Inc., 30 Church St., New York City, announces that on July 1, its New England Branch at Boston, will suspend local operations and that K. H. Nilsson, having been appointed to the New York office, the New England sales and service of the Bolinders oil engine will be handled from there.

The Foxboro Co., Inc., manufacturer of recording and indicating instruments, Foxboro, Mass., announces that C. H. Roessner has been appointed district sales manager with offices at 1510 Monadnock Bldg., Chicago, Ill., and that A. F. Mundy, formerly of the Chicago office, will represent the company in southern California with offices in the Pacific Finance Bldg., Los Angeles.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	June 11, 1923	June 18, 1923
Pool 1,	New York	$3.50@4.00	$3.50@4.00
Smokeless,	Columbus	4.00@4.50	3.75@4.10
Clearfield,	Boston	2.25@3.00	2.00@2.75
Somerset,	Boston	2.50@3.25	2.50@3.00
Kanawha,	Columbus	1.90@2.20	1.90@2.20
Hocking,	Columbus	1.75@2.00	1.75@2.10
Pittsburgh No. 8	Cleveland	2.00@2.10	1.85@2.00
Franklin, Ill.	Chicago	3.00@3.25	3.00@3.25
Central, Ill.	Chicago	2.00@2.25	2.00@2.25
Ind. 4th Vein,	Chicago	2.50@2.75	2.50@2.75
West Ky.,	Louisville	1.65@1.85	1.65@1.85
S. E. Ky.,	Louisville	2.00@2.50	2.00@2.25
Big Seam,	Birmingham	1.85@2.25	1.85@2.25

FUEL OIL

New York—June 21, Port Arthur light oil, 22@25 deg. Baumé, 5⅜c. per gal.; 30@35 deg., 5¾c. per gal., f.o.b. Bayonne, N. J.

Chicago—June 9, 24@26 deg. Baumé, $1.97 per bbl.; 32@36 deg., $2.27 per bbl., tank cars.

St. Louis—June 12, tank-car lots, f.o.b. St. Louis: 24@26 deg., $1.75 per bbl.; 26@28 deg., $1.80 per bbl.; 28@30 deg., $1.90 per bbl.; 32@36 deg., gas oil, $2.05 per bbl.; 36@40 deg., distillate, $2.25 per bbl.

Pittsburgh—June 19, f.o.b. local refinery, 30@34 deg., fuel oil, 4½c. per gal.; 36@40 deg., fuel oil, 5½c. per gal.; 34 deg., neutral, 8½c. per gal.

Dallas—June 16, f.o.b. local refinery, 26@30 deg., $1.57 per bbl.

New Plant Construction

PROPOSED WORK

Ark., Van Buren—Water Improvement Dist. 1, C. M. Wofford, Secy., will receive bids until June 28 for (a) sedimentation basin and filters; 40 ft. well; 22 x 38 ft. pump house; intake well, c.i. and vit. pipe; valves: (b) filter equipment and appurtenances, including piping strainer systems with brass strainers, gauges, valves, filter sand and gravel, chemical dry feed machines for 2 units of 500,000 g.p.d. each; alternate A—as above except strainer system of wrought iron pipe; alternate B—as above except strainer system of Wheeler Filter Bottom: (c) two 550 g.p.m. split shell centrifugal pumps with 10 hp. motor, etc.; two 500 g.p.m. single acting triplex pumps with 75 hp. motor, etc.; one 200 g.p.m. split shell centrifugal pump with 5 hp. motor, etc.; (d) 30,000 gal. steel tank with eliptical bottom on 45 ft. tower with 36 in. riser; (e) Van Buren valves, 76 d.g., 2 to 12 in.; eighty valve boxes; ninety-seven fire hydrants; (f) pipe, castings and flanged specials; (g) laying and setting pipe and hydrants; repairing reservoir; (h) cleaning force main; (i) water meters. W. L. Winters, Fort Smith, Engr. Noted Feb. 13.

Ark., Texarkana—The First Natl. Bank has had plans prepared and will receive bids about July 1 for the construction of an 8 story bank and office building, including steam heating system. Estimated cost $250,000, Sanguinette, Staats & Herrick, First Natl. Bank Bldg., Fort Worth, Tex., Engrs. and Archts.

Calif., Long Beach—F. Stillwell, c/o Russell & Alpaugh, Archts., Story Bldg., Los Angeles, is having plans prepared for the construction of a 12 story apartment building on 3rd and Cedar Sts., here. Estimated cost $750,000 or more. Equipment detail not reported.

Calif., Los Angeles—S. H. Blevin, c/o Walker & Eisen, Archts., Pacific Finance Bldg., is having plans prepared for the construction of a 10 story hotel on Wilshire and Hampshire Sts. Cost will exceed $500,000. Equipment detail not reported.

Calif., Los Angeles—H. K. Elder, et al., Story Bldg., is having plans prepared for the construction of a 14 story hotel and store building on Francisco and 7th Sts. Cost will exceed $850,000. Curlett & Beelman, Union Bank Bldg., Los Angeles, Archt. Equipment detail not reported.

Calif., Los Angeles—The Ray Productions, 1425 Fleming St., are having plans prepared for the construction of a moving picture plant, consisting of a group of studio buildings on Beverly Blvd. and 1st St. Cost will exceed $2,000,00. H. Cross, Merchants Natl. Bank Bldg., Los Angeles, Archt. Equipment detail not reported.

Calif., Marysville—The Marysville Hotel Co., c/o E. Glass, Archt., Underwood Bldg., San Francisco, is having plans prepared for the construction of a 6 story hotel on 5th and E Sts., here. Estimated cost $300,000. Equipment detail not reported.

Calif., Oakland—M. F. Smith, 1001 Excelsior Ave., is having plans prepared for the construction of a 6 story, 100 x 190 ft. store and hotel building on 12th and Oak Sts. Estimated cost $250,000. J. J. Donovan, 1916 Broadway, Oakland, Archt. Equipment detail not reported.

Colo., Denver—The Denver Natl. Bank, 17th and Curtis Sts., is having plans prepared for the construction of a 12 story, 100 x 125 ft. bank and office building. Estimated cost $1,000,000. H. W. J. Edbrooke, Colorado Theatre Bldg., Denver, Archt. Equipment detail not reported.

Conn., Middletown — The Connecticut Power Co., 335 Main St., is having plans prepared for the construction of a 2 story power station on Water St. Stone & Webster, 147 Milk St., Boston, Engrs. Eng. Dept. of Hartford Electric Light Co., 266 Pearl St., Hartford, Archts.

Conn., New London — The Connecticut College for Women, Mohegan Ave., B. T. Marshall, Mohegan Ave. and National St., Pres., plans to build a 2 story library; hall; 3 story, 80 x 100 ft. and 80 x 150 ft. dormitories; chapel. Estimated cost $175,000, $250,000, $150,000, $175,000 and $150,000 respectively. Engineer or architect not selected.

D. C., Wash.—The Washington Automobile Apartment Corp., J. M. House, c/o Washington Mortgage & Finance Co., International Bldg., Pres., plans to build an automobile hotel apartment building on New York Ave. between 13th and 14th Sts., N. W. Estimated cost $1,000,000. Engineer or architect not selected.

Idaho, Lewiston—The city, J. R. Turnbull, Clk., voted $380,000 bonds for the construction and installation of purification plant, pumping plant, reservoirs and distribution system. Noted Mar. 20.

Ill., Chicago—The Addison Bldg. Corp., c/o B. F. Steif, Archt., 64 West Randolph St., is having plans prepared for the construction of a 6 story apartment building, including steam heating system, on Broadway and Addison St. Estimated cost $500,000.

Ill., Chicago—E. P. Doerr, 1226 Madison Park Ave., is having plans prepared for the construction of two 3 story, 36 x 165 ft. apartment buildings, including steam heating system, at 4817-29 Lake Park Ave. Estimated cost $300,000. W. P. Doerr, 28 East Jackson Blvd., Archt.

Ill., Elgin—C. Ackerman, 17 Rugby Pl., representing owner, is having plans prepared for the construction of a hotel, including steam heating system. Estimated cost $300,000. S. N. Crowen, 10 La Salle St., Chicago, Archt.

Ill., Springfield—The city holds an election June 26 to vote on $350,000 bonds for the construction of waterworks improvements, including high and low service pump; softening and iron removal plant; basins and filters. Burns & McDonnell, 402 Interstate Bldg., Kansas City, Mo., Engrs.

Ia., Washington—The city, J. J. Kellogg, Clk., is having plans prepared for the construction of a water pumping plant, elevated tank and additional wells. Estimated cost $75,000. A. L. Mullergren, 555 Gates Bldg., Kansas City, Mo., Engr.

Kan., Kansas City—The city, A. Darby, Purch. Agt., will soon be in the market for two pumps for sewer work and to be used in case of flood.

Ky., Louisville — The Methodist Episcopal Deaconess Hospital, 8th St., plans to build an addition to its hospital to double present capacity. Estimated cost $300,000. Engineer or architect not selected.

La., Shreveport—E. Weil, Archt., Whitney Central Bldg., New Orleans, is preparing plans and will receive bids about Sept. 5 for the construction of a 90 x 150 ft. opera house on Crockett and Louisiana Sts., for Ehrlich Bros., here. Estimated cost $750,000, including $250,000 for equipment.

Mass., Boston—The Bd. of Public Wks., J. A. Rourke, Comr., City Hall, plans to build a 10 story hospital with addition for nurses' home on Harrison St. and Massachusetts Ave. Estimated cost $1,500,000. Engineer or architect not selected.

Mich., Battle Creek—G. C. Maass, 67 Yuba St., is having sketches prepared for the construction of a 7 story apartment hotel on Marshall St. Estimated cost $500,000. Bellingham & Cobb, Kalamazoo, Archts.

Mich., Detroit—Beckett & Akitt, Archts., 73 Monroe Ave., are preparing plans for the construction of a 13 story, 50 x 140 ft. apartment house, including steam heating system on Cass Ave. Estimated cost $500,000. Owner's name withheld.

Mich., Detroit—The Dept. of Public Wks. received bids for the construction of a 53 x 131 ft. pumping station, including 60 x 120 ft. pump pit and suction well, on Pleasant Ave., from Natl. Constr. Co., 1031 Dime Bank Bldg., Detroit, $177,700; Lennane & McIlvenna, 1121 Book Bldg., Detroit, $234,849.67; F. H. Davis Co., 1860 Penobscot Bldg., $268,000. Noted May 3.

Minn., Hutchinson—The city, J. Mikulecky, Clk., will receive bids until June 29 for the construction of waterworks improvements, consisting of 16 in. well about 180 ft. deep, one 300 g.p.m. centrifugal service pump, two 500 g.p.m. centrifugal booster pumps, one 100,000 gal. tank on 100 ft. tower. Estimated cost $15,000. C. L. Pillsbury Co., 1200 2nd Ave., Minneapolis, Engrs.

Minn., St. Paul—The Citizens Service Corp., 601 Selby Ave., is having plans prepared for the construction of a 12 story store and office building, including steam heating on 6th and Jackson Sts. Estimated cost $800,000. Toltz, King & Day, 1410 Pioneer Bldg., St. Paul, Archts.

Miss., Jackson—The Capital Ice Co., W. M. Wright, Pres., is in the market for ice manufacturing machinery and equipment, electrically driven.

Miss., Jackson—The Lamar Life Insurance Co., W. Welty, Pres., is having plans prepared and will receive bids Aug. 1 for the construction of a 10 story, 82 x 148 ft. and 50 x 120 ft. office building, including steam heating system. Estimatetd cost $500,000. Sanguinette, Staats & Hedrick, 1st Natl. Bank, Fort Worth, Tex., Engrs. and Archts.

Miss., Vicksburg—The city is having plans prepared for furnishing and installing 3 or more pumping plants in connection with drainage project and land reclamation along river front. Cost to exceed $25,000. Miller Butterworth Co., 624 Southern Trust Co. Bldg., Little Rock, Ark., Engrs. Separate contracts will be awarded.

Mo., Jefferson City—The Executive Com. of Curators of Lincoln University, 100 New York Life Bldg., Kansas City, will receive bids until June 29 for the construction of boiler house, smoke stack, plumbing, sewering, conduits, boiler, pumps, water heater and generator, vacuum pumps and pipe lines at Lincoln University. E. C. Janssen, 1301 Chemical Bldg., St. Louis, Engr.

Mo., Kansas City—H. C. Darnell & Co., 14th and Elmwood Sts., are in the market for a 150 hp. oil engine and a 13 kw. generator.

Mo., Kansas City—Horner & Wyatt, Consult. Engrs., 316 McMillian Bldg., A. Horner, Purch. Agt., are in the market for three electrically driven centrifugal pumps to open 5 and 25 total head, combined capacity for 250 second ft. 3 phase 60 cycle, 2,300 volt.

Mo., King City—The city, C. E. Potter, Clk., will receive bids until June 27 for the construction of a waterworks system, including mains; hydrants; valves; 75,000 gal., 125 ft. water tower; 14 x 28 ft. well; pumphouse; one 165 g.p.m. triplex pump and motor. Estimated cost $60,000. E. T. Archer & Co., New England Bldg., Kansas City, Engrs.

Mo., St. Louis—The St. Louis Coffin Co., 1821 Chouteau Ave., F. W. Gardener, Pres., is changing plant from d.c. to a.c. and is in the market for motors and chain drives.

N. J., East Orange—The Homeopathic Hospital, c/o Crow, Lewis & Wicks, Engrs. and Archts., 200 5th Ave., New York, are having plans prepared for the construction of a 6 story hospital, here. Estimated cost $450,000. Equipment detail not reported.

N. J., Trenton—The State, Comr. of Educ., State House, will receive bids until July 2 for the installation of engines and generators, electrical equipment and wiring, refrigerating plant. Estimated cost $35,000. Guilbert & Betelle, Commerce Chamber Bldg., Newark, Engr. A. H. Moses, Temple Bldg., Camden, Archt.

N. Y., Buffalo—The Selden Mfg. Co., 55 Selden St., Detroit, Mich., have had plans prepared for the construction of a 4 story hotel on Utica St., here. Estimated cost $250,000. Lewis & Hill, 892 Main St., Buffalo, Archts. Equipment detail not reported.

N. Y., Hornell—The Hornell Electric Co., 30 Canastota St., has been granted a permit by the Public Service Comn., for the construction of and extension of its electric plants in the towns of Hornellsville and Dansville.

N. Y., Lockport—The Bd. of Supervisors of Niagara County had plans prepared for the construction of a county home and hospital. Estimated cost $1,600,000. R. Kidd, Buffalo, Archt. Equipment detail not reported.

N. Y., New York—G. Backer, Inc., 295 5th Ave., will build by separate contracts a 14 story office building on East 47th St. Estimated cost $1,000,000. Equipment detail not reported.

N. Y., New York—The Harriman Natl. Bank, 44th St. and 5th Ave., plans to build a 15 story bank and office building. Engineer or architect not selected.

N. Y., Schenectady—The General Electric Co., River Rd., plans to build a 3 story factory building at the west end of present plant. Estimated cost $125,000.

N. Y., Utica—The Utica Gas & Electric Co., 222 Genesee St., plans to build a 6 story office and testing building on Lafayette and Cornelia Sts. Cost between $175,000 and $200,000.

N. D., Grand Forks—The city plans to build a 10 ft. rock dam across the Red

River of the North to develop power for municipality.

Ohio, Akron—Rapp & Rapp, Archts., 190 North State St., Chicago, are receiving bids for the construction of a 3 story store, shop and theatre building, including steam heating system, on Main and High Sts., here, for the Akron Enterprise Corp. Estiated cost $850,000. Noted Nov. 21, 1922.

Ohio, Cincinnati—The University of Cincinnati, Burnet Woods Park, is having plans prepared for the construction of a School of Applied Arts, addition to engineering building, Tanner's Council of America research building and a college of law building. Estimated cost $600,000, $200,000, $110,000 and $250,000 respectively. H. Hake, Telephone Bldg., Cincinnati, Archt.

Pa., Oil City—The Citizens Light & Power Co., Chambers Bldg., is having plans prepared for rerouting all its lines, light and power, also changes in distributing system. Day, Zimmerman Co., 611 Chestnut St., Phila., Engrs.

Pa., Pittsburgh—The Pennsylvania R.R., Central Region, G. Nauman, 1155 Liberty Ave., Engr. in charge, is in the market for Deane vertical hydraulic pump, air compressors and hydraulic accumulator, 112 ft. dia. pit.

Pa., Williamsport — The Bd. of Dirs. of the School Dist., H. A. Sterner, Secy., 229 West 3rd St., will receive bids until July 9 for steam heating plant and ventilating system for Wm. Penn School; steam heating system as auxiliary to present system in Josiah Emery School; boiler with motor for ventilating fan in Benjamin Franklin School.

Tenn., Covington—The city voted $71,000 bonds for repairs to water and light plant. Contract was awarded for the installation of an oil-burning engine and miscellaneous equipment to Fairbanks, Morse & Co., 900 South Wabash Ave., Chicago, Ill.

Tenn., Lawrenceburg—The city is having plans and surveys made for the construction of a hydro-electric dam over Shoal Creek for municipal light plant. Freeland, Roberts Co., Independent Life Bldg., Nashville, Consult. Engrs. Noted Apr. 17.

Tex., Forth Worth—The city received compiete bids for the construction of South Side pumping plant, including equipment from H. W. Greenway, 214 Hemphill St., Fort Worth, $72,402.50; McKenzie Constr. Co., Calcasieu Bldg., San Antonio, $73,-537.50. Noted May 29.

Wis., Edgerton—The Edgerton Memorial Hospital Assn. is in the market for refrigeration machinery, etc., for proposed $100,-000 hospital.

Wis., Ellis Junction (Crivitz P. O.)—Mead & Seastone, Engrs., Journal Bldg., Madison, are receiving bids for switchboard, outdoor substation, two penstocks, 200 ft. long; six 12 x 14 ft. tainter gates, two 4 x 4 ft. sluice gates, here, for the Wisconsin Public Service Co., 559 Marshall St., Milwaukee. Noted May 29.

Wis., La Crosse—O. A. Merman, Archt., Linker Bldg., and the La Crosse Lutheran Hospital Assn., 1910 South Front St., will receive bids until July 2 for remodeling power house and the construction of a 3 story, 42 x 100 ft. nurses' home. Estimated cost $150,000. The owner is in the market for power and heating boilers.

Wis., Madison—The University of Wisconsin, M. E. McCoffery, Secy., is having plans prepared for the construction of a 1 story heating plant, including two boilers, piping, etc. Estimated cost $88,000. J. C. White, c/o State Heating Plant, Madison, Engr.

Wis., Marinette—The Menominee & Marinette Light & Traction Co. is having plans prepared for excavation of tail race, additional vertical units, flood and sluice gates. Mead & Seastone, Journal Bldg., Madison, Engrs.

Wis., Milwaukee—The Western Ice & Coal Co., 601 Security Bldg., R. Werner, Purch. Agt., is in the market for ice making machinery.

Wis., Oshkosh—J. Danke, 332 Main St., is in the market for dairy machinery, including testers, churns, belting, shafting and refrigeration machinery for proposed creamery.

Wis., Peshtigo—The North Eastern Power Co., 559 Marshall St., Milwaukee, is having plans prepared for the installation of a new 4,000 kva. unit in power plant, also strengthening old dam, including abutments, gates, etc., here. Estimated cost $50,000. Mead & Seastone, Journal Bldg., Madison, Engrs.

Wis., Seymour—M. G. Hollada is in the market for refrigeration machinery, motor driven.

Wis., Thorp—The city, C. W. Wolf, Clk., is having plans prepared for the construction of a tank, sludge aeration and circulation type sewage disposal system with pumping equipment consisting of small air compressor, motor and two airlift pumps. Estimated cost $25,000. W. G. Kirchoffer, Dean Bldg., Madison, Engr.

Wis., Watertown—The city, F. Schmultzer, Secy., Water Dept., is having plans prepared for drilling and cleaning old well, also the installation of pumping equipment and air compressor. Estimated cost $25,000. W. G. Kirchoffer, Dean Bldg., Madison, Engr.

Ont., Ailsa Craig—The town plans the installation of a waterworks system, including electric pumps, mains, hydrants, reservoir, etc. Estimated cost $30,000. Engineer not selected.

Ont., Kitchener — Watt & Blackwell, Archts., Bank of Toronto Bldg., London, will receive bids until July 3 for the construction of a 3 story, 50 x 180 ft. hospital with two 42 x 105 ft. wings, including steam heating and signal systems, electric elevators and dumb waiters, here, for the Sisters of St. Joseph, c/o A. Thecla, 204 Park St., N., Hamilton. The architect is in the market for boilers, radiation and hospital equipment.

Ont., Port Colborne—The Council, I. H. White, Town Clk., will have plans and estimates prepared for the construction of a waterworks system, including filtration and pumping plants. Estimated cost $80,000. Engineer not selected. The owner is interested in prices of materials and equipment.

Ont., Toronto—St. Michaels Hospital, 30 Bond St., plans to build a hospital including steam heating system with mechanical ventilation, motor driven, on Victoria St. Estimated cost $500,000. Engineer or architect not selected.

CONTRACTS AWARDED

Calif., Long Beach—C. J. Harper, Sea Gull Apartments, awarded the contract for the construction of a 10 story store, hotel and club building on Ocean Blvd., to A. W. Baruch, 236 South Plymouth St., Hollywood. Estimated cost $750,000. Equipment detail not reported. Noted May 15.

Calif., Los Angeles—The Sun Realty Exch., 5508 South Vermont St., awarded the contract for the construction of a 12 story store and office building on Hill St. to J. V. McNeil & Co., H. W. Hellman Bldg., Los Angeles. Estimated cost $500,-000. Equipment detail not reported.

Calif., Sacramento—The Sisters Hospital, c/o R. A. Herold, Archt., Forum Bldg., awarded the contract for the construction of a 5 story hospital on 40th and J Sts. to W. C. Keating, Capitol Natl. Bank Bldg., Sacramento. Estimated cost $398,800. Heating and plumbing not incldued in contract. Noted May 15.

Calif., San Diego—R. Hicks, et al., c/o W. H. Wheeler, Archt., Spreckels Bldg., awarded the contract for the construction of a 5 story theater, office and store building on E and 4th Sts. to the Wurster Constr. Co., 746 Central Ave., Los Angeles. Estimated cost $500,000. Equipment detail not reported.

Calif., San Francisco—The Pacific Gas & Electric Co., 445 Sutter St., awarded the contract for the construction of a 2 story power house, conduit, pumps, etc., at the Potrero Gas Plant, to the Tibbetts-Pacific Co., 16 California St., San Francisco. Estimated cost $110,000. Pumps and machinery will be furnished the contractor by the owner. Noted June 12.

Fla., Miami—E. C. McAllister, 320 12th St., awarded the contract for the construction of a 9 story, 100 x 140 ft. store building and hotel on Flagler St., to the G. W. Langford Co., Miami. Estimated cost $500,-000. Equipment detail not reported.

Ill., Chicago—B. H. Aarens, Archt. and owner, 109 North Dearborn St., awarded the contract for the construction of a 3 story, 99 x 264 ft. apartment, store and office building on Racine and Grace Sts. to H. Sjoblom, 4225 North Western Ave., Chicago. Estimated cost $500,000. Steam heating system will be installed.

Ill., Chicago—The Rettig Bldg. Corp., 6707 Stony Island Ave., awarded the contract for the construction of a 10 story, 124 x 269 ft. apartment building on 67th St. and Stony Island Ave. to the B. W. Constr. Co., 720 Cass St. Estimated cost $3,500,000. Steam heating system will be installed. Noted May 29.

Ill., Chicago—The Western Shade Cloth Co., 2000 South Jefferson St., have engaged Lockwood, Greene & Co., Engrs., 24 Federal St., Boston, Mass., to design and erect a steam power house.

Kan., Horton—The city awarded the contract for the construction of an earth dam with spillway and intake, flow line, clear water storage reservoir and a high service pump station to Ziegler & Dalton, Junction City; c.i. pipe to the United States Cast Iron Pipe Fdry. Co., 604 Interstate Bldg., Kansas City. Noted May 8.

La., Shreveport—The Washington Hotel Co., E. K. Smith, Pres., awarded the contract for the construction of an 8 story, 150 x 150 ft. hotel, including elevators, laundry and refrigeration system, on Edwards and Travis Sts. to Ault & Burden, Little Rock, Ark. Estimated cost $1,000,000.

Mo., Fulton—The city will build by day labor a 1 story, 45 x 100 ft. power plant and engine house. Estimated cost $30,000. The owner is in the market for two boilers and chain stokers, later will buy other equipment for municipal power plant and waterworks.

Mo., Kansas City—The Kansas City Life Insurance Co., Rialto Bldg., awarded the general contract for the construction of a 3 story, 140 x 160 ft. office building on Broadway and Arrow St. to Collins Bros., 1600 Grand Ave., Kansas City. Estimated cost $1,000,000. Equipment detail not reported. Noted Mar. 20.

Mo., Kansas City—The Liberty Memorial Assn., R. A. Long Bldg., awarded the contract for the construction of a memorial building to the Westlake Constr. Co., Railway Exch. Bldg., St. Louis. Estimated cost $1,142,250. Equipment detail not reported. Noted Sept. 26, 1922.

Mo., St. Louis—The Missouri Pacific R.R., Railway Exch. Bldg., will build by day labor a 1 story, 54 x 92 ft. power plant at Chouteau Ave. Estimated cost $50,000.

Neb., Omaha—George & Co., 902 City Natl. Bank Bldg., awarded the contract for the construction of a 4 story, 70 x 420 ft. office and store building to the J. Black Masonry & Contg. Co., 515 Federal Reserve Bank Bldg., Omaha. Estimated cost $750,-000. Equipment detail not reported.

N. Y., New York—The Owners' Improvement Corp., c/o Shape, Bready & Peterkin, Inc., Engrs. and Archts., 50 East 42nd St., awarded the contract for the construction of a 10 story apartment at 2-10 East 86th St. to T. W. Stemmler, Jr., Inc., 52 Vanderbilt Ave., New York. Estimated cost $1,500,000. Equipment detail not reported.

Ohio, Cleveland—The Brodhead-Garrett Co., 2835 East 51st St. J. C. Rash, Asst. Secy., awarded the contract for the construction of a 1 story, 300 x 360 ft. warehouse, 40 x 40 ft. dry kiln, 40 x 50 ft. planing mill, boiler house, office and garage on East 71st St. along tracks of Belt Line R.R. to the A. A. Lane Constr. Co., 7869 East 55th St., Cleveland. Estimated cost $150,-000. Noted May 8.

Ohio, Cleveland — The Cleveland Public Library Bd., c/o E. H. Whitlock, Kinney-Levan Bldg., awarded the contract for the construction of a 4 story, 199 x 216 ft. library building, including steam heating system, on East 3rd St. and Superior Ave., to the Lundoff-Bicknell Co., 5716 Euclid Ave., Cleveland. Estimated cost $4,000,000. Noted May 8.

Ohio, Cleveland—The Standard Oil Co. of Ohio, J. R. Frost, Mgr., East Ohio Gas Bldg., awarded contracts for steam power plants at 2800 Broadway and 65th St. and East River to the James Stewart Co., 30 Church St., New York.

S. D., Watertown—The city awarded the contract for the construction of filtration plant to the Watertown Cement Products Co., Watertown, $36,214; sea wall, F. W. Schreiber, Watertown, $8,000. Bids were rejected on pumps and equipment. Noted May 22.

Tex., Dallas—The Methodist Conference, c/o J. H. Gresclose, 807 Mercantile Bank Bldg., will build by day labor an 8 story, 114 x 171 ft. hospital, first unit, including laundry, heating plant, offices, etc., on Ballard and Grove Sts. Estimated cost $400,-000. C. W. Ives, 807 Mercantile Bank Bldg., Dallas, Supt. of Constr. Noted May 29.

Wis., Neenah—The Valley Paper Mills, N. Nash, Genl. Supt., 145 Wisconsin Ave., awarded the contract for the construction of a 4 story paper mill, including superstructure of main factory, finishing room, power house and filtration plant to the Appleton Constr. Co., Odd Fellows Bldg., Appleton. Estimated cost $150,000. Power machinery, belting and shafting will be required. Noted Feb. 27.

Ont., Hamilton—The Bd. Educ., R. H. Foster, Secy., awarded the contract for the construction of a 2 story Collegiate Institute, to contain 25 rooms, on Main St., E., to the W. H. Yates Constr. Co., Main St., E., Hamilton. Estimated cost $447,000. Steam heating system will be installed.

Volume 57 June 26, 1923 Number 26

POWER

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Engineering News-Record **American Machinist**
Power **Chemical and Metallurgical Engineering**
Coal Age **Engineering and Mining Journal-Press**
Ingeniería Internacional
Bus Transportation **Electric Railway Journal**
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The annual subscription rate is $3 in the United States and Canada, Alaska, Hawaii, the Philippines, Porto Rico, Canal Zone, Cuba, Mexico, Honduras, Nicaragua, Dominican Republic, Salvador, Panama, Peru, Colombia, Brazil, Bolivia, Ecuador Guatemala, Costa Rica, Argentina, Uruguay, Paraguay and Spain. Extra foreign postage $3 (total, $6, or 25 shillings). Single copy, 15 cents.

Change of Address—When change of address is ordered the new and the old address must be given. Notice must be received at least ten days before the change takes place.

Published Weekly. Entered as Second-Class Matter, Dec. 20, 1910, at the Post Office at New York under the Act of March 3, 1879
Printed in U. S. A. Established 1880.

Member Audit Bureau of Circulation. Member Associated Business Papers, Inc.

NUMBER OF COPIES PRINTED THIS ISSUE, 29,600

Moments with the Ad Editor

Power Again Leads

As Reference for Prime Movers Committee

The 1923 Report of the Prime Movers Committee of the National Electric Light Association was distributed at the recent N.E.L.A. convention and has been released to the press.

This document published annually is accepted as the most authoritative on the subject of central station power generation. The 1923 report totals 372 pages and covers practically every phase of power generation.

Bibliography is cited extensively on the subjects of Station Piping, Power Station Heat Balance, Treatment of Feedwater, Pulverized Fuel, Boilers, Superheaters and Economizers, Liquid and Gaseous Fuels, and Oil and Gas Engines.

Ninety-five articles are cited from eight American power-plant publications while forty-one scattering mentions are credited to eighteen publications of miscellaneous appeal.

Of the ninety-five articles credited to power-plant publications, POWER received forty-four or over 46%. No other publication received more than eighteen mentions (less than 20%).

POWER is proud to have contributed so much valuable data to the Central Station industry in 1923 as in previous years. To have been mentioned in their engineering bibliography more than twice as often as any other publication is an inspiration to greater effort in the future.

Keystone Manifold Safety Lubricator

Patent Applied for

Eliminates Risk and Waste

THE Keystone Manifold Safety Lubricator presents a method of applying grease under high pressure with pipe-line distribution to more than one bearing. It accomplishes this result without risk to the operator or waste of grease. Bearings that are difficult of access, due to small clearances between working parts, heat and other unfavorable conditions, are made easy to reach by this medium, thus insuring the proper lubrication of bearings that otherwise might be neglected because of inconvenience and hazardous conditions.

The illustration shown above is of the Keystone Safety Lubricator with No. 8 manifold attached, also ½-in. metallic tubing. The lubricators are of heavy cast-iron construction and finely machined. The manifolds are connected to the lubricator by union and short nipples. They are of aluminum construction with brass valves finely fitted.

	Capacity		Outlets
Lubricator	1 lb.	No. 1 Manifold	11
Lubricator	4 lb.	No. 4 "	15
Lubricator	8 lb.	No. 8 "	21

Send for booklet describing the Keystone Manifold Safety Lubricator showing typical installations.

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Parts are interchangeable, made so by careful a d standardized manufacture.

Nation-wide distribution, through supply houses everywhere, carries Jenkins Valves to every locality.

Jenkins Valves are made in Bronze, Iron, and Steel for all requirements.

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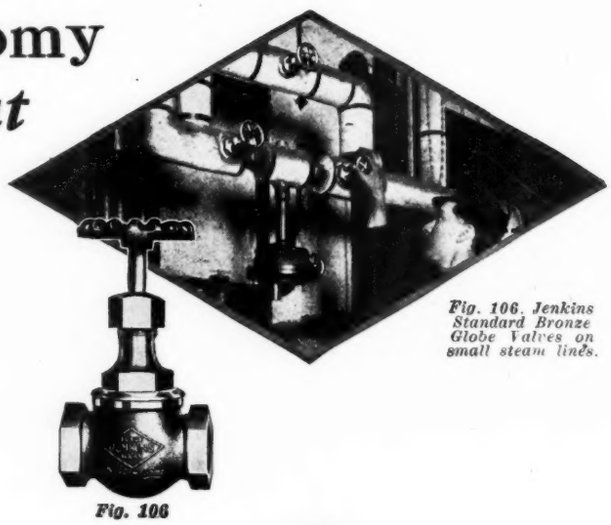


Fig. 106. Jenkins Standard Bronze Globe Valves on small steam lines.

Fig. 106

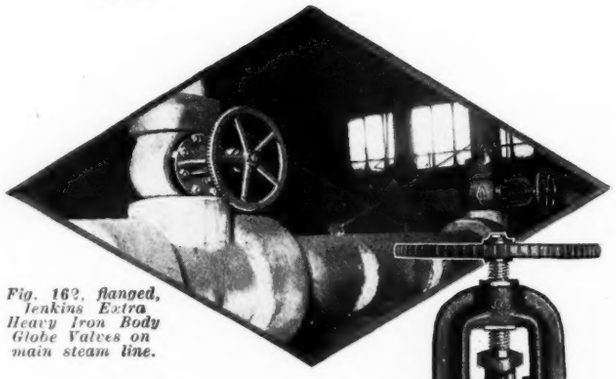


Fig. 162, flanged, Jenkins Extra Heavy Iron Body Globe Valves on main steam line.

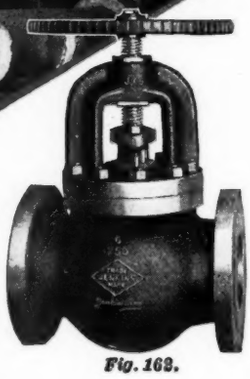


Fig. 162.

Fig. 141.

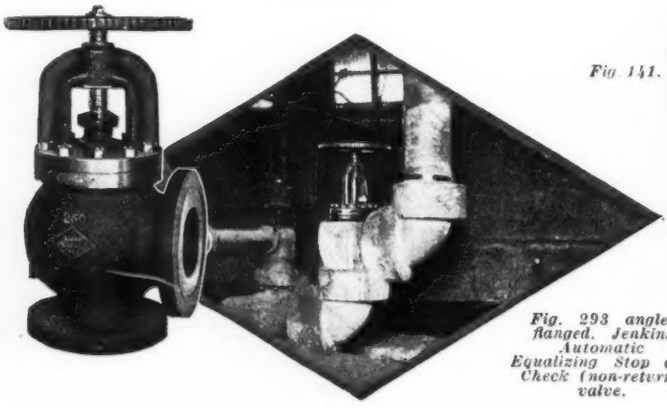
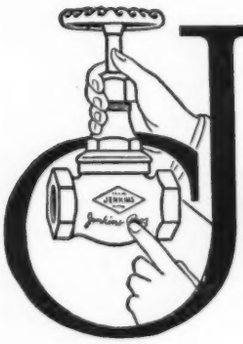


Fig. 293 angle, flanged, Jenkins Automatic Equalizing Stop and Check (non-return) valve.

Fig. 141, screwed, Jenkins Standard Iron Body Globe Valve on boiler feed line.

2839-J



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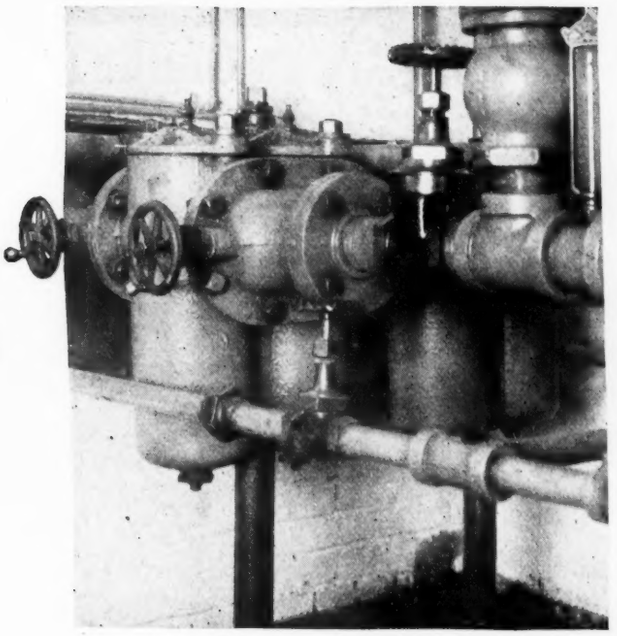
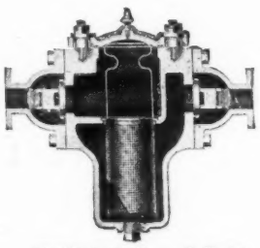
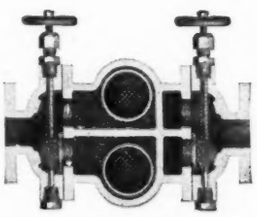
—for continuous straining of fuel or lubricating oil



Installation of 2 Twin Oil Strainers, Widener Bldg., Philadelphia, Pa.



Vertical Section of Twin Oil Strainer. Oil enters at left, flows down through basket and out at right.



Horizontal Section of Twin Oil Strainer. Gate Valves control inlet and outlet as shown.

A Twin Oil Strainer, tucked away somewhere in the pipe line, is an assurance against clogged fuel oil burners or lubricating oil line passages. These Strainers are unsurpassed for a compact, serviceable installation, giving absolutely continuous service.

Twin Oil Strainers, having two separate straining chambers, may be cleaned while in service. Shifting the valves directs the flow of oil from one chamber to the other, and the idle chamber may be quickly opened and the basket cleaned.

Made in sizes from 1-inch to 5-inches, with screwed connections in sizes 2-inch and below. Basket mesh to suit the service.

Request Descriptive Bulletin "AA"

AA-110

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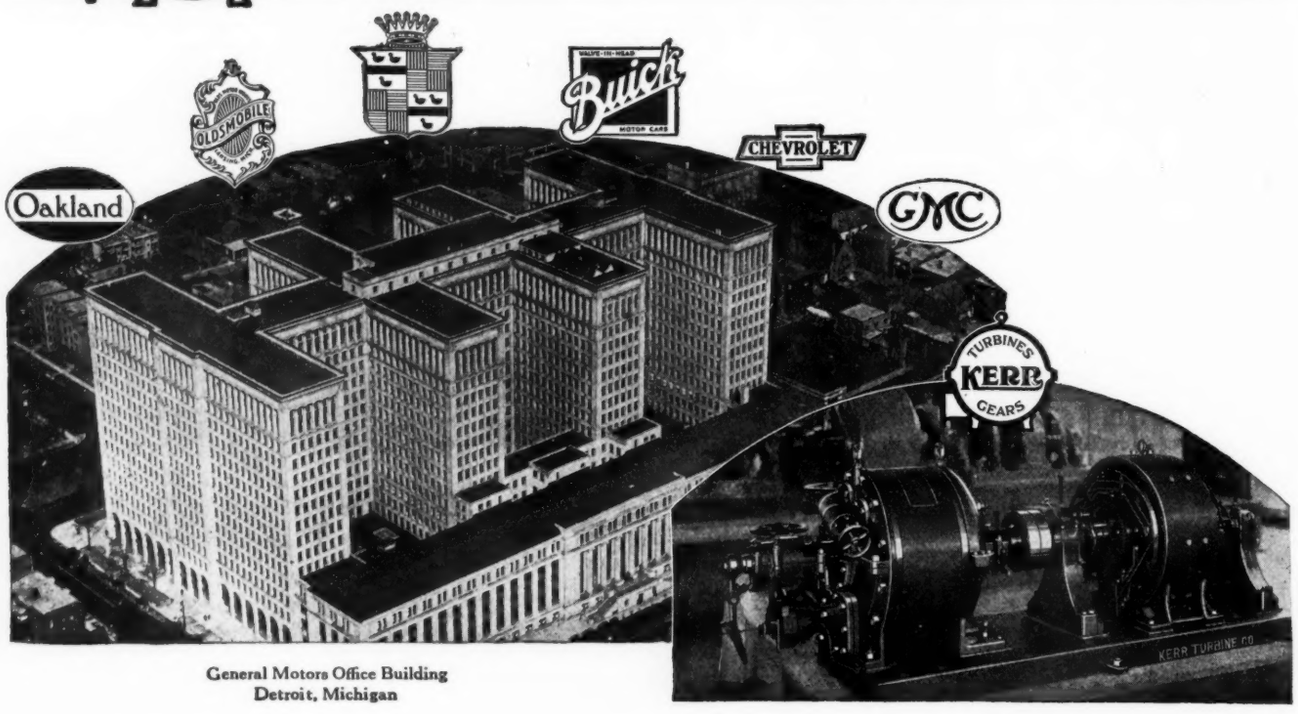

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You can well remember the time when auto owners were satisfied with any machine that was an improvement over walking. But today a car is rated as worthless unless it is *reliable.*

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This demand for reliability is one reason why the COPES System is used in nearly all of the large central stations, and large industrial plants, and in thousands of smaller plants.

With COPES Regulation you "Have no difficulty whatever."

"We are delighted with our COPES Regulators, and have had no difficulty whatever since first putting them to work. As you know we later equipped all our coal boilers with COPES, and regard them as a very well defined and positive economy."—*Thos. F. Judge, Supt., Anglo Newfoundland Development Co., Ltd., Great Falls, Newfoundland.*

This is merely one example of the dependable service that thousands of plants, the world over, are getting from the COPES System. Boiler feeding that is reliable, and

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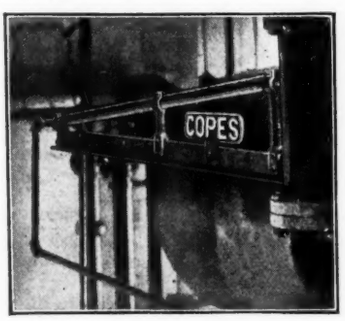

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Simply a metallic expansion tube, attached to a balanced valve. That is all there is to it — no springs or diaphragms, no floats or displacement bodies, no pilot valves; nothing to refill.

This simple mechanism gives accurate feeding by the *variable-water-level* principle. It responds instantly to every sudden drop in the load, by momentarily increasing the feed rate to store heat.

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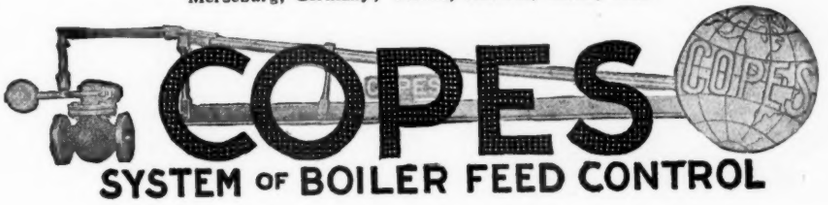
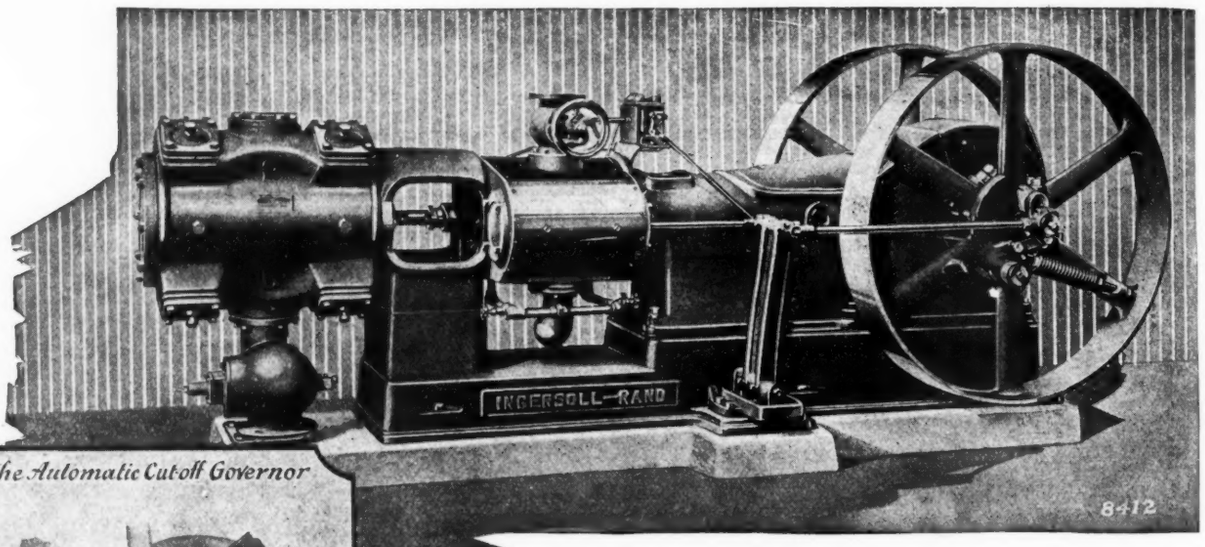
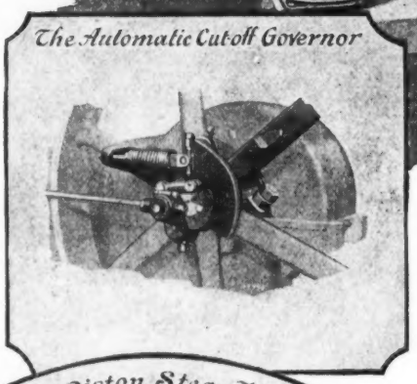
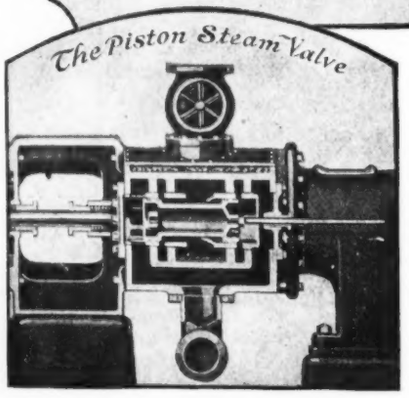


SYSTEM OF BOILER FEED CONTROL







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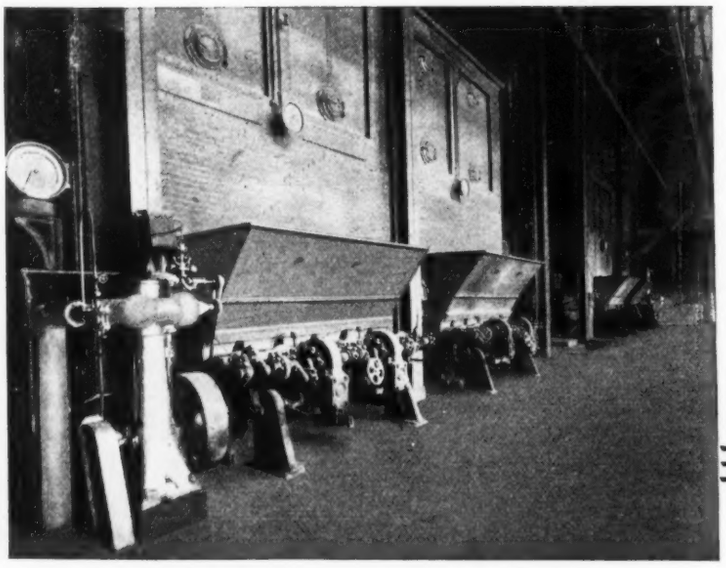

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How a big Pennsylvania Steel Mill accomplished this result is of vital interest to every engineer and executive where power plants are being erected or remodeled.

The load in this plant was formerly carried by twenty-four 500 hp. boilers. The stacks smoked badly. The plant could not get enough power. After some investigation the management installed

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"The Pioneer Underfeed Stoker—and still leading!"

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But these are not the only results of the switch to Taylor Stokers. Several hundred horsepower is generated in this plant by boilers fired by gas from blast furnaces. Formerly, when the gas failed, they had to round up a gang and hand-fire these boilers with coal. Now, the Taylor Stokers automatically pick up the additional load. And not only do the Taylors jump to the sudden and unexpected overload, but they carry it for long, unbroken runs as well. The Taylor Stokered Boilers, 22 of which are usually on the line, require only three firemen and two helpers.

Which all comes down to this—that the answer to the demand for increased plant capacity is not more or bigger boilers, but TAYLOR STOKERS.

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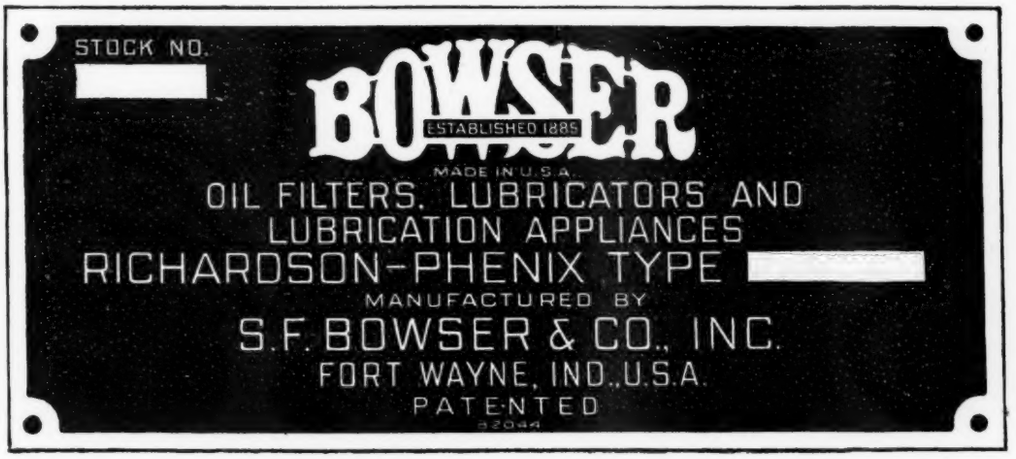

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It is your safeguard against shut-downs—your assurance of full production.

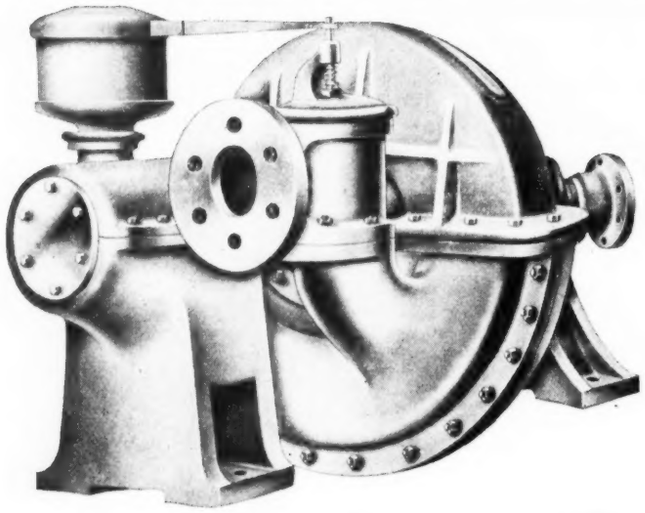
Our engineering department is ready to provide you with standard R-P units individually engineered to meet your requirements. Address Dept. 6.

S.F. BOWSER & COMPANY, Inc.
Pump and Tank Headquarters
FORT WAYNE, INDIANA.
Sales and Service Offices and Representatives Everywhere

TANKS DEPENDABLE PUMPS

BOWSER ESTABLISHED 1885

A Worthy Addition to London Turbine Products



Introducing the Two-Bearing Turbine for Super-Station Work—a Design Requested by our Many Satisfied Stoker Drive Users—

Specifications:

CASING: The casing on cylinder is supported at the center line by **TWO** massive pedestal bearings (instead of feet) so arranged that the casing is free to expand in either direction without disturbing the shaft or flexible coupling alignment, due to expansion of casing.

Built to withstand the very high pressures and temperatures now in demand.

Casing split horizontally at center line to afford easy inspection, without breaking steam or exhaust piping joints.

GOVERNOR: Vertical type, geared from main shaft. Reliable, excellent regulation; similar to those used on large turbines. Admittedly more satisfactory than shaft type.

VALVE: Bronze, balanced.

BEARINGS: Pedestal type—spherical, self-aligning—babbitt construction—pedestals and bearings water-cooled.

GLANDS: Labyrinth type—our standard design—similar to the glands on YOUR large turbines.

Can withstand 25 pounds back pressure without adjustment or modification.

EMERGENCY OVERSPEED GOVERNOR: Duplicate weight type—positive—quickly closing a butterfly valve furnished with turbine.

ROTOR: Single stage—steel—two and three rows of moving blades.

DESIGNED EXPRESSLY FOR THE SUPERPOWER STATION OF TOMORROW. AN IMPROVEMENT AND ASSET TO YOUR PLANT OF TODAY.

Write for Bulletin or Consult our Nearest Office or Representative

London Steam Turbine Co., Troy, N. Y.

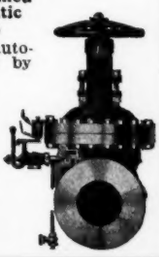
GOLDEN-ANDERSON
Pat. Automatic Cushioned Steam Pressure Reducing Valves

1. Maintain a constant reduced pressure.
2. Thoroughly cushioned.
3. No hammering, chattering or sticking.
4. No auxiliary valves or small by-passes to clog up.
5. No wire drawing.
6. Only one adjustment from the outside.
7. Double extra heavy throughout — practically indestructible.

GOLDEN-ANDERSON
Patent Automatic High and Low Pressure Steam Traps

1. The first new departure in steam trap design, in years.
2. 50 to 100% greater capacity than other traps of similar size.
3. Full area through discharge valve.
4. Extra Heavy Throughout — Very Durable — Will last a lifetime — and *Always Works.*
5. Furnished Semi-Steel and Cast Steel for Superheat.

GOLDEN-ANDERSON
Pat. Cushioned Combined Throttle and Automatic Engine Stop Valves



1. Operate 3 ways: Automatically, by Hand, or by Electric Switch.
2. Prevent Fly-wheel Explosions.
3. "Double Corliss" Cushioned—No Pounding or Sticking.
4. Contains No Tight Fitting Parts.
5. Furnished in Angle and Globe Patterns for High or Low Pressures.
6. "Always Ready for Service."

"No Shutdown When a Tube Ruptures—"

"No Explosion When a Steam Pipe Bursts"

Disaster That Comes Unwarned—

Loss of life and destruction of valuable plant equipment may follow in the wake of a sudden reversal of steam flow from the main header back into a boiler in which a tube has let go.

Likewise fatalities are imminent when a steam pipe bursts, releasing the tremendous energy in the steam pouring out of every boiler. PROTECT YOUR PLANT from these dreaded results from such accidents by installing

GOLDEN-ANDERSON

Patent Automatic Double-Cushioned Triple-Acting and Non-Return Valves

"Every Valve With an Absolute Guarantee"

"Hosts of References"

"Heaviest Valves Made"

Used by leading power plants throughout the world. Time has proved them to be LIFE and PROPERTY INSURANCE VALVES—because they have never failed to protect.

1st. **Prevent expensive shut-downs**—Automatically close in case of boiler or steam line ruptures.

2nd. **Make back flow of steam impossible.**

3rd. **Equalize pressure** between boilers, automatically—quickly pay for themselves in reduced coal bills alone.

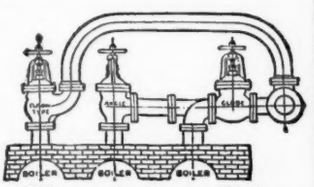
4th. **Absolutely protect** men inside of "dead" boilers.

5th. **Valves fitted** with "Double Corliss" dashpots. Absolutely cushion valve—no hammering or sticking.

6th. **Provide for every contingency** by "automatic" testing in service feature—valves closed from floor to remote points.

7th. **Heaviest and most correct** mechanically constructed and operated automatic valves made.

Also made in plain non-return style for protecting the boilers only.



Elbow, Angle or Globe Patterns

4250 **Double Extra Heavy Valves Ordered by the Large Iron and Steel Companies**

GOLDEN-ANDERSON
Pat. Automatic Cushioned Water Pressure Regulating Valves

1. Maintain a constant reduced pressure regardless of fluctuations on high pressure side.
2. Perfectly Cushioned by water and air. No metal-to-metal seats.
3. The best valve made for maintaining a constant low pressure where consumption is continuous.
4. Operates quickly or slowly as required—No attention necessary.
5. Positively no hammering or sticking. Sizes to 24 in.

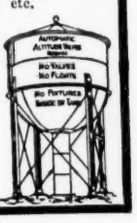
GOLDEN-ANDERSON
Pat. Automatic Cushioned Water Float Valves

1. Automatically Maintain Uniform Water Levels in Tanks, Standpipes, etc.

2. Instantly Adjusted to Operate Quickly or Slowly.
3. Floats Swivel to any Angle—Most Satisfactory Float Valves Known.
4. No Metal-to-Metal Seats — No Water, Hammer or Shock.
5. Cushioned by Water and Air.

GOLDEN-ANDERSON
Pat. Cushioned Automatic Controlling Altitude Valves

1. Automatically Maintain Uniform Water Levels in Tanks, Standpipes, Reservoirs, etc.
2. For High or Low Pressure. Always Dependable.
3. No Floats or Fixtures used.
4. No Water Hammer or Shocks.
5. Sizes up to 30 in.



Golden-Anderson Valve Specialty Co., 1217 Fulton Bldg., Pittsburgh, Pa.

MODERN

are vastly different from those of yesterday.

For instance—the plant equipped with

Lopulco Pulverized Fuel Systems

will burn any available fuel

Coal Oil Natural Gas

INTERNATIONAL COMBUSTION

Combustion Engi

Combustion Engineering Bld

Offices in Principal Cities

Frederick Multiple Retort Stokers
Type E Stokers
Type D Stokers
Type K Stokers
Type H Stokers
Self Contained Stoker

COMBUSTION ENGINEERING CORPORATION NEW YORK

METHODS

The largest boilers in the world are Lopulco fired.

The highest records of efficiency in fuel burning is held by the Lopulco Systems.

Write for data and information on fuels burned by Lopulco Pulverized Fuel Systems.

ENGINEERING CORPORATION

ineering Corporation

43 Broad Street New York City

Throughout the World

Green Chain Grate Stokers
Green Cast Iron Hoppers
Green Pressure Waterbacks
Quinn Fuel Oil Equipment

Lopulco Pulverized Fuel Systems
Coxe Stokers
Grieve Grates
Air Heaters
CEC Tube Scraping Device
Combusco Water Seal Conveyor

LUNKENHEIMER Gate Valves

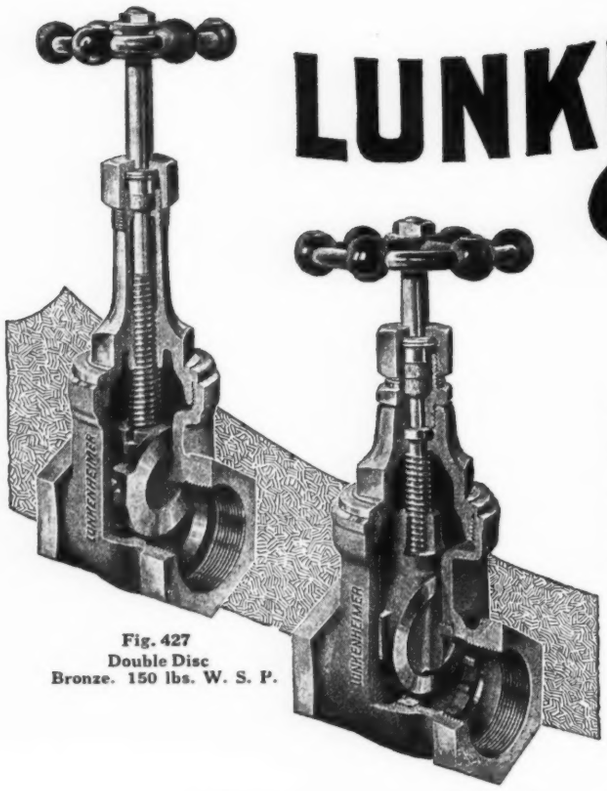


Fig. 427
Double Disc
Bronze. 150 lbs. W. S. P.

Fig. 768
Wedge Disc
Bronze. 200 lbs. W. S. P.

The complete line of Lunkenheimer Gate Valves (part of which is here illustrated) enables the selection of designs particularly adapted for specific purposes and for all prevailing pressures and temperatures.

The designs, materials and workmanship are of the Lunkenheimer Standard and therefore satisfactory prolonged service and economy of maintenance are assured.

Catalog 58DB portrays the complete line. Write for a copy.

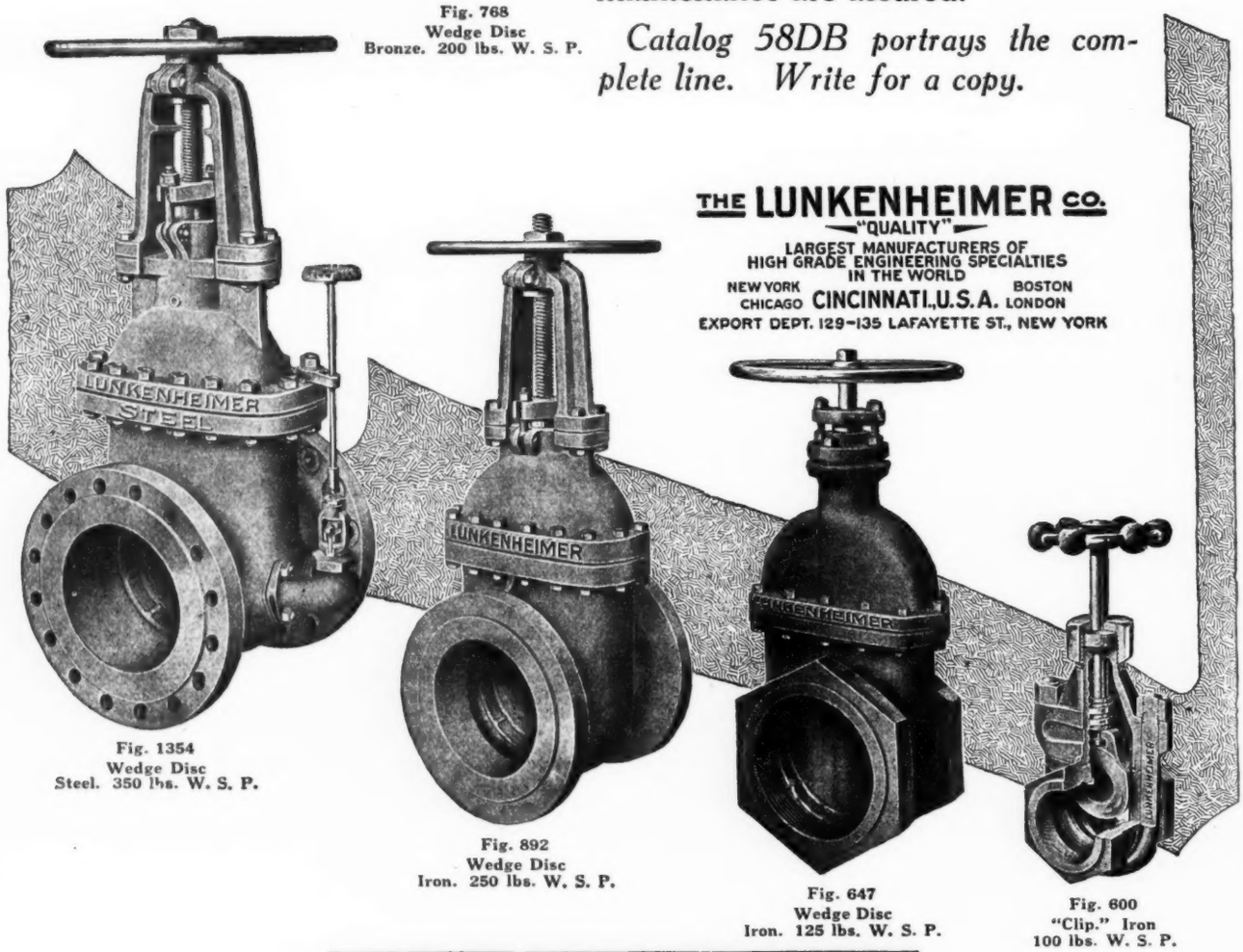


Fig. 1354
Wedge Disc
Steel. 350 lbs. W. S. P.

Fig. 892
Wedge Disc
Iron. 250 lbs. W. S. P.

Fig. 647
Wedge Disc
Iron. 125 lbs. W. S. P.

Fig. 600
"Clip." Iron
100 lbs. W. S. P.

THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD
NEW YORK BOSTON
CHICAGO **CINCINNATI, U.S.A.** LONDON
EXPORT DEPT. 129-135 LAFAYETTE ST., NEW YORK

"America's Best since 1862"

600-31-42

Features

—for Cash Standard users only

INSTALL one Cash Standard Regulator and learn the meaning of these six advantages that only Cash Standard users can enjoy. You buy the Cash Standard Reducing and Regulating Valve on the old fashioned but still unbeaten basis of absolute satisfaction or money back. Your name on the coupon below is all that is necessary.

CASH STANDARD

You will find them in no other valve—

1. Wire drawing eliminated. Seat opening comparatively small in relation to inlet opening. It must, therefore, open wide to permit passage of desired volume. This eliminates wire drawing.

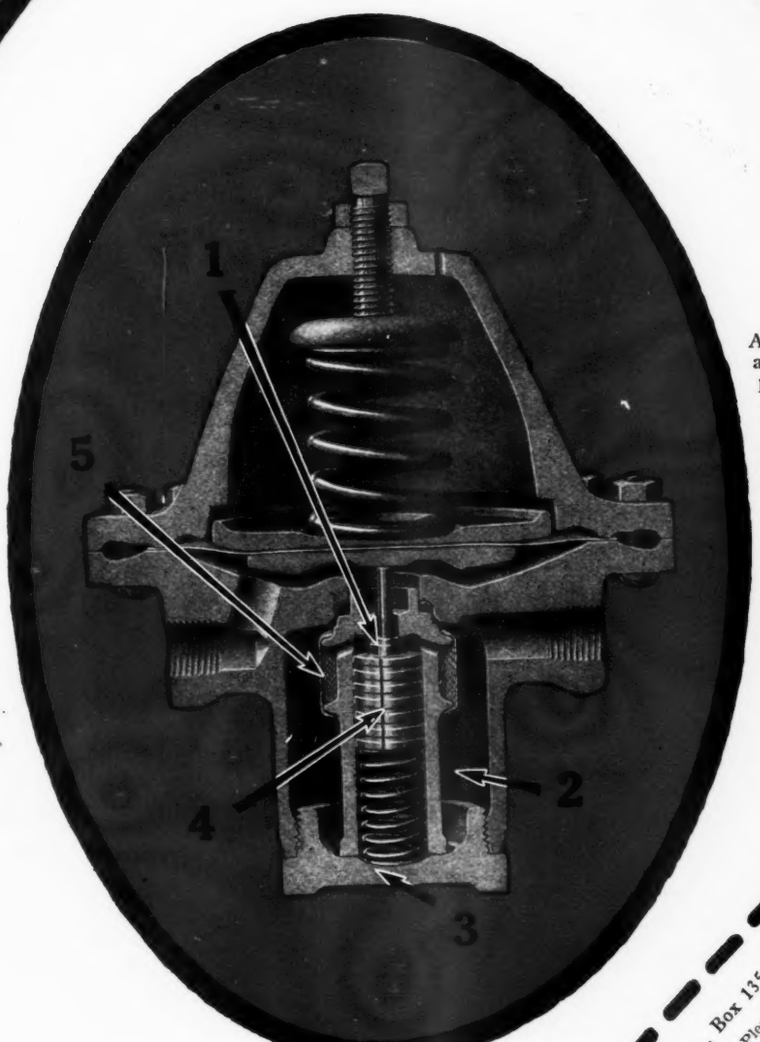
2. No seizing or sticking. Inside operating parts entirely surrounded by and subjected to steam at the same temperature. Since they necessarily expand and contract equally, binding and sticking is impossible.

3. Accessibility. Simply unscrew cap and remove all inside working parts for cleaning or regrinding.

4. Closes with the high pressure. Steam passes through duct in the valve piston so valve closes with the high pressure behind it. The high pressure closes valve.

5. Self-contained strainer. Located close to the seat—not on the line as in other regulators. Heads off foreign substances right at the seat. No separate strainer needed.

6. Simplicity. Entire operating mechanism comprises one simple unit. Simple and sturdy in construction. No levers, bearings, packing or external dashpots.



Also makers of ammonia expansion valves, ammonia controlled water regulators, relief valves, back pressure valves, automatic cut-off valves, pump governors, fan engine regulators, vacuum relief valves, strainers, and special valves.

Makers of Craig Damper Regulator—

A. W. Cash Co., Box 135, Decatur, Ill.
A. W. Cash Co. of Canada, Ltd.
146 King St. W., Toronto
Branches in Principal Cities

A. W. Cash Co., Box 135, Decatur, Illinois,
☐ Please send me the Cash Standard Catalog—no obligation.
☐ Tell me how to order a Cash Standard Regulator on the satisfaction-or-money-back basis.

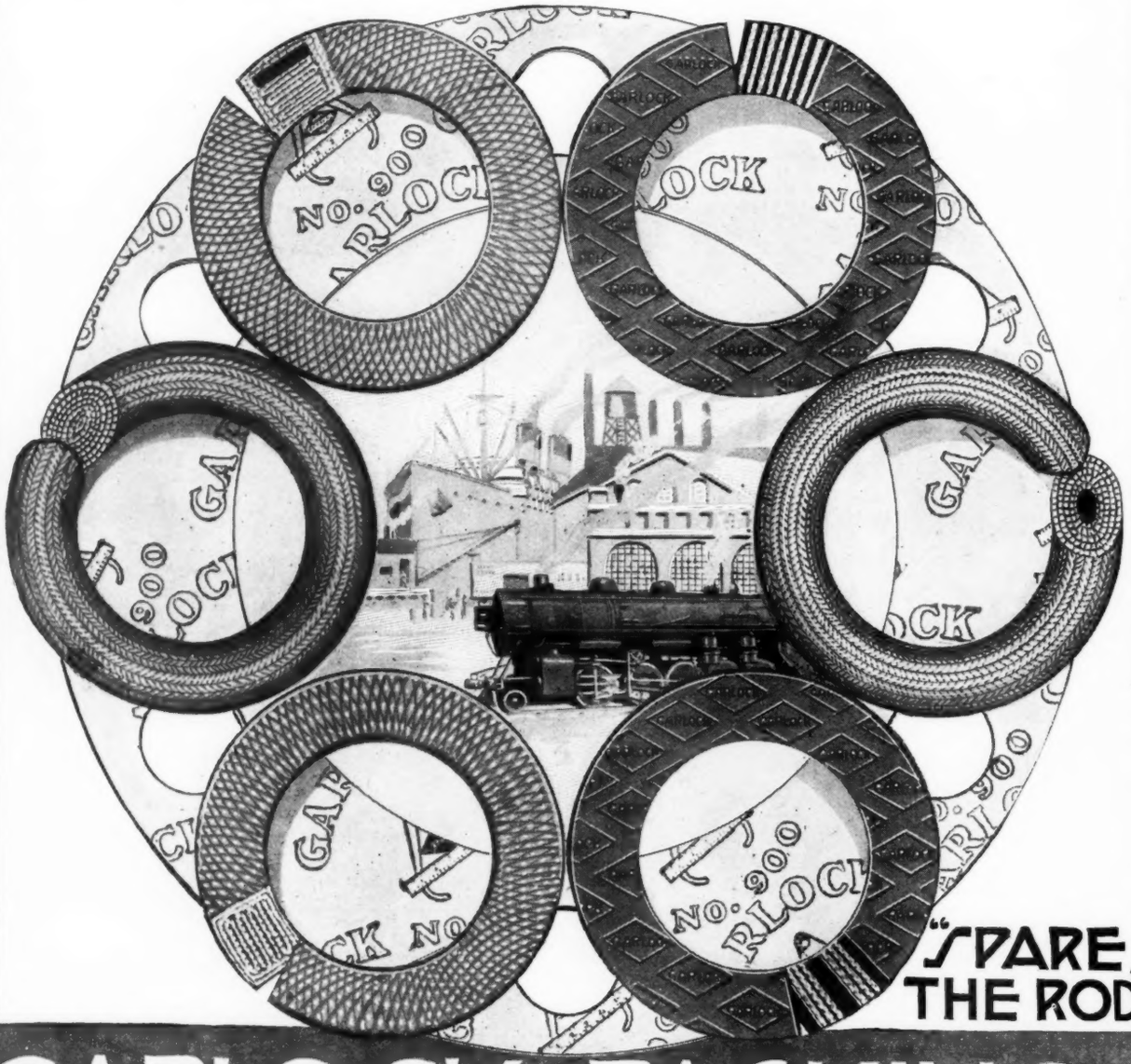
Company .....
Address .....
My Name .....

IN ENGINEERING CIRCLES

It Is the Operating Engineer Who Most Appreciates Reliability

Hours spent renewing rod packing and replacing gaskets, often in inaccessible places, have proven to him the fact that quality is the main consideration when purchasing packing. Added to this is the saving due to minimum rod friction and leakless joints.

On your next order specify GARLOCK, the packing of world-wide reputation and known reliablilty.



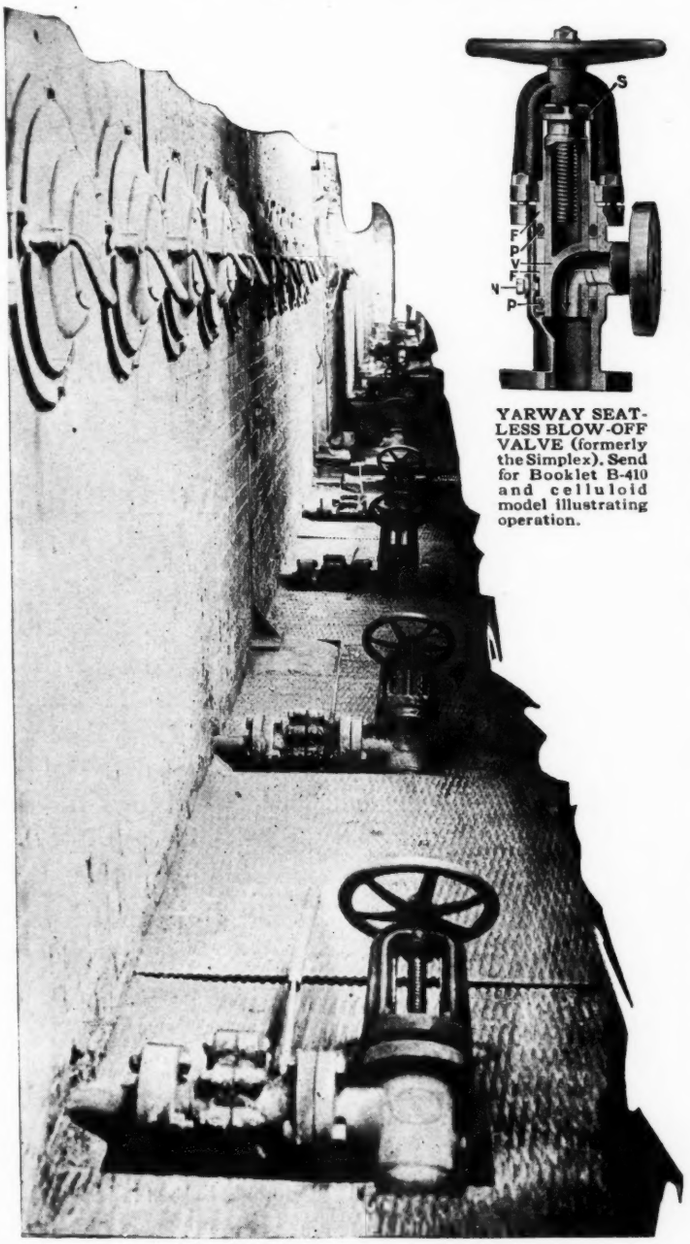
GARLOCK PACKINGS

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

BRANCHES:

New York, Chicago, Philadelphia, St. Louis, Boston, Cleveland, Pittsburgh, San Francisco, Denver, Birmingham, Hamilton, Ont.

The South, too, Prefers Yarway Seatless Blow-off Valves



These YARWAY SEATLESS BLOW-OFF VALVES are saving steam in the plant of the Montgomery Light & Traction Co., Montgomery, Ala.

YARWAY SEATLESS BLOW-OFF VALVE (formerly the Simplex). Send for Booklet B-410 and celluloid model illustrating operation.

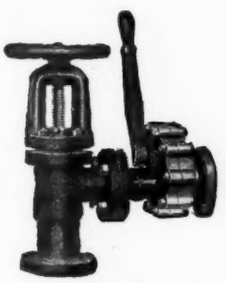
IN THE South, as in every other part of the country, Yarway Seatless Blow-off Valves are the choice of many of the largest and most successful plants.

The illustration shows 16 Yarway Seatless Blow-off Valves at the Montgomery Light & Traction Co., Montgomery, Ala. Other well-known Southern plants that are saving steam with Yarway Valves include Alabama Power Co., Memphis Gas & Electric Co., Norfolk & Western R. R., Texas Co., Virginia Railway & Power Co., Dixie Portland Cement Co., Potomac Electric Power Co.. and many others.

The "no-seat-to-leak" construction of the Yarway Seatless keeps it tight through years of hard service, with no discs or seat to regrind or replace.

Interesting information about the Yarway Seatless and the Yarway Double-Tightening Valves is given in Booklet B-410. Tell us where to send your copy.

YARNALL-WARING CO.
Mermaid Ave.
PHILADELPHIA



The YARWAY TANDEM—YARWAY SEATLESS and YARWAY DOUBLE-TIGHTENING VALVES in combination. Unconditionally guaranteed for two years.

YARWAY

POWER PLANT DEVICES *to save fuel*

Campbells' Soups

LOOK FOR THE RED-AND-WHITE LABEL

THE CAMPBELL'S SOUP KITCHENS require an enormous supply of steam in preparing the millions of cans of Campbell's Soups which housewives are demanding in ever increasing quantities. Like many other nationally known concerns they have installed Riley Stokers in their power plant at Camden, N. J.

When Campbell's Soups set out to find
The stoker best for the daily grind
Of making steam for every need
They chose the Riley Underfeed.

When steam is wanted quickly Riley Stokers can be depended upon to meet the need. The first turn of the cranks sets the grates in motion. The shearing action of the "moving grates" instantly breaks up the fuel surface, allows the air to mingle with the coal. A flood of power is released to meet sudden demands.

There is no watching nor waiting—poking nor slicing — the stoker responds instantly and in four or five minutes the boiler will be operating at $2\frac{1}{2}$ or even 3 times rating.

This is but one reason why the Riley is being used so largely by America's leading industrial concerns.

For a complete description ask for Catalog P-6

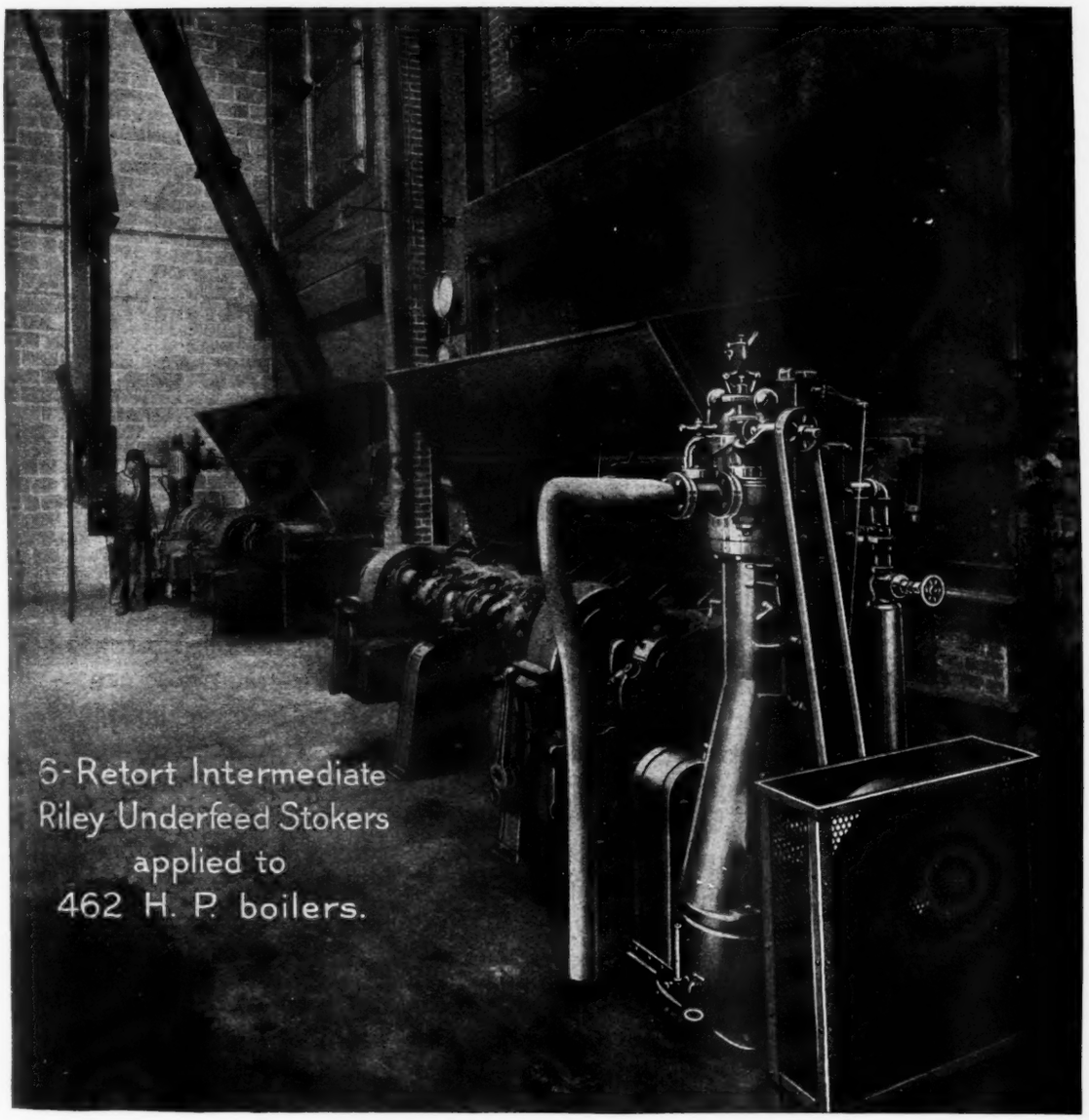
SANFORD RILEY STOKER COMPANY

SANFORD RILEY STOKER

"RILEY" Underfeed Stokers *"JONES" Underfeed Stokers* *"MURPHY" Automatic Furnaces*

GROUND COAL ENGINEERING CORP. — Pulverized Coal Installations

SELECT RILEY UNDERFEED STOKERS



6-Retort Intermediate
Riley Underfeed Stokers
applied to
462 H. P. boilers.

COMPANY, Worcester, Mass.

SANFORD RILEY STOKER COMPANY

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT
CINCINNATI CHICAGO ST. PAUL KANSAS CITY DENVER CHARLOTTE DALLAS

The UNDERFEED STOKER COMPANY OF CANADA, LTD., TORONTO.

Fire-Brick chewed out and cracked after exposure to heat. This means shutting down a boiler for days while new Bricks are set up in place of the old ones. Johns-Manville Heat Treatment reduces this shut-down and replacement expense.

Weak joints

One reason furnace linings get old too soon

BOILER furnace masonry is no better than its bonding cements. Ordinary fire-clays that fuse or crumble away, weaken fire-brick by leaving the edges and sides exposed. The brick "heat soaks" and fuses or spalls away. An early shut-down for repairs or replacement is the result.

Proper "bonding" of fire-brick for modern furnace conditions requires two things: better refractory cements and better methods of application. These are both included in Johns-Manville Heat Treatment. The high temperature cements used resist fusion and have the elasticity and strength to stand compression stresses. The method of application reduces under cutting at the joints and damage from clinker adhesion.

Johns-Manville Heat Treatment cuts down maintenance and saves the time loss of unnecessary boiler shut-downs—a double economy.

View of a boiler furnace, grates removed, treated with Johns-Manville High Temperature Cement. This setting will resist heat, prevent premature checking or spalling and will retard the adhesion of clinker.

JOHNS-MANVILLE Inc., Madison Ave. at 41st St., N. Y. C.
Branches in 59 Large Cities
For Canada: CANADIAN JOHNS-MANVILLE CO., Ltd., Toronto

JOHNS MANVILLE SERVICE
COVERS THE CONTINENT
Through
Asbestos
and its allied products
INSULATION
BRAKE LININGS
ROOFINGS
PACKINGS
CEMENTS
FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE
Power Plant Materials

A Challenge

WE will take a plant equipped with any type of stoker manufactured in the United States and get *better* results than the experts sent out by the stoker manufacturers.

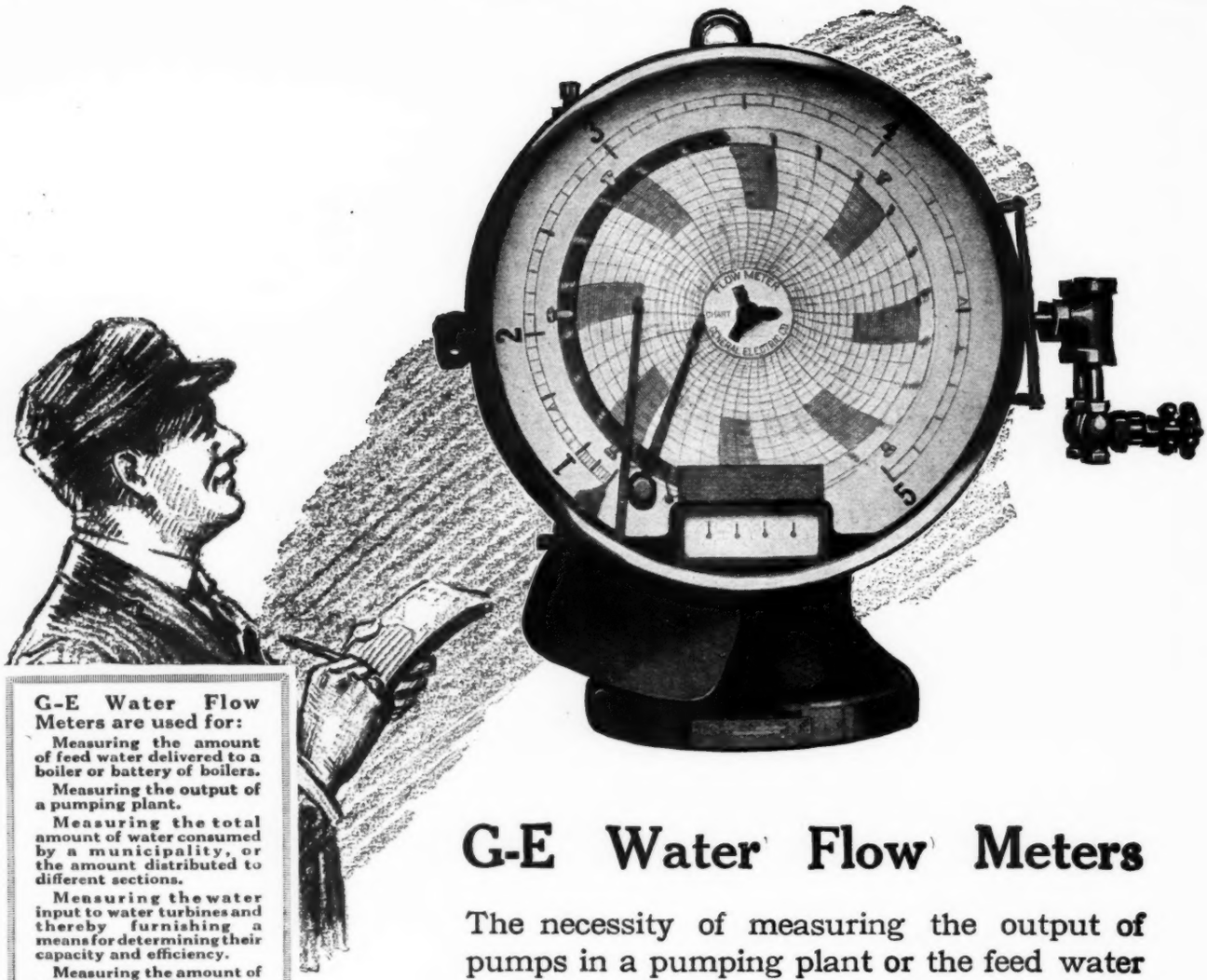
Further, once Hagan Regulation is installed, the results are immediate and lasting, *and do not end when the expert leaves the plant.*

The truth of these statements have been proven time and time again in connection with the following stokers:

Taylor	*Westinghouse*
Riley	*Harrington*
Jones	*Murphy*
Detroit	*Green*
Coxe	*Type "E"*
Roney	*and others*

Write for our latest Bulletin on Hagan Boiler Regulation—
now ready

Hagan Corporation
Combustion and Chemical Engineers
PITTSBURGH



G-E Water Flow Meters are used for:

Measuring the amount of feed water delivered to a boiler or battery of boilers.

Measuring the output of a pumping plant.

Measuring the total amount of water consumed by a municipality, or the amount distributed to different sections.

Measuring the water input to water turbines and thereby furnishing a means for determining their capacity and efficiency.

Measuring the amount of water consumed in manufacturing processes.

Measuring the amount of cooling water used in condensers.

Determining the slippage losses in pumps, due to leaky plungers or valves.

Discovering losses due to leaks in water mains, etc.

Discovering sudden fluctuations of flow which would cause dangerous water hammer.

G-E Water Flow Meters

The necessity of measuring the output of pumps in a pumping plant or the feed water admitted to boilers in a power plant is too well known to need emphasis.

In order to secure accurate data, thoroughly reliable meters must be used. G-E water flow meters are sturdy and simple in construction and dependable in operation.

Ask our nearest office for further information

General Electric Company

General Office
Schenectady, N. Y.

Sales Offices in
All Large Cities

G-E Flow Meters

for measuring steam, air, water, etc.

A GENERAL ELECTRIC PRODUCT

34C-64

Have you as much confidence in us as we have in you?

HAVE you ever stopped to consider the full meaning of the offer below? It shows not only our confidence in the superiority of Armstrong Traps—but also our confidence in *you*. If you have as much confidence in us

—*then you will accept this offer*

We are willing to send this trap to any engineer in good standing for *ninety days* because we know that such an engineer will make it his business to *get acquainted* with the Armstrong Trap within that time. We are willing to let the trap stand on its own merit, and we are willing to stand or fall on the result of the most rigid test that you can devise.

Since our purpose is simply to demonstrate the merits of the Armstrong Trap, and to prove our constantly repeated claim that "the Armstrong is different," we have carefully avoided what is often called a "free trial offer." As you will see, when you read the "Request for Test" blank below, you simply agree to test an Armstrong Trap for 90 days *and then return it!*

Your good will and confidence is all we seek. Have we got it. If so, fill out the blank.

ARMSTRONG MACHINE WORKS
312 Maple St., Three Rivers, Michigan

Armstrong Steam Trap

REQUEST FOR TEST— P-6-26-23

To ARMSTRONG MACHINE WORKS,
312 Maple St., Three Rivers, Mich.

Please ship, charges prepaid, an Armstrong Steam Trap, per specifications belo
test purposes. It is understood that this trap may be retained at least ninety
order to test its various features and that when test is completed the trap is
returned to the Armstrong Machine Works, charges collect.

Size of trap ..... Size of pipe connections ..... *Pressure.....

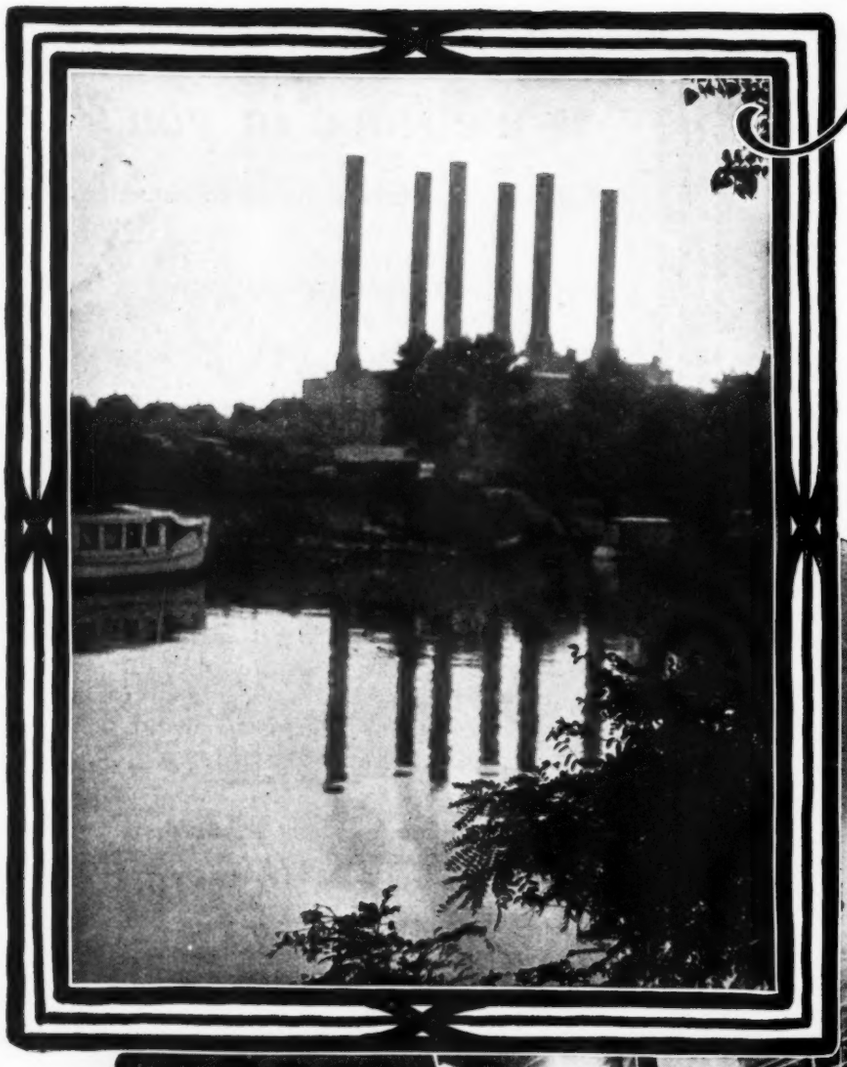
*Important—Do not neglect to state maximum pressure on trap.

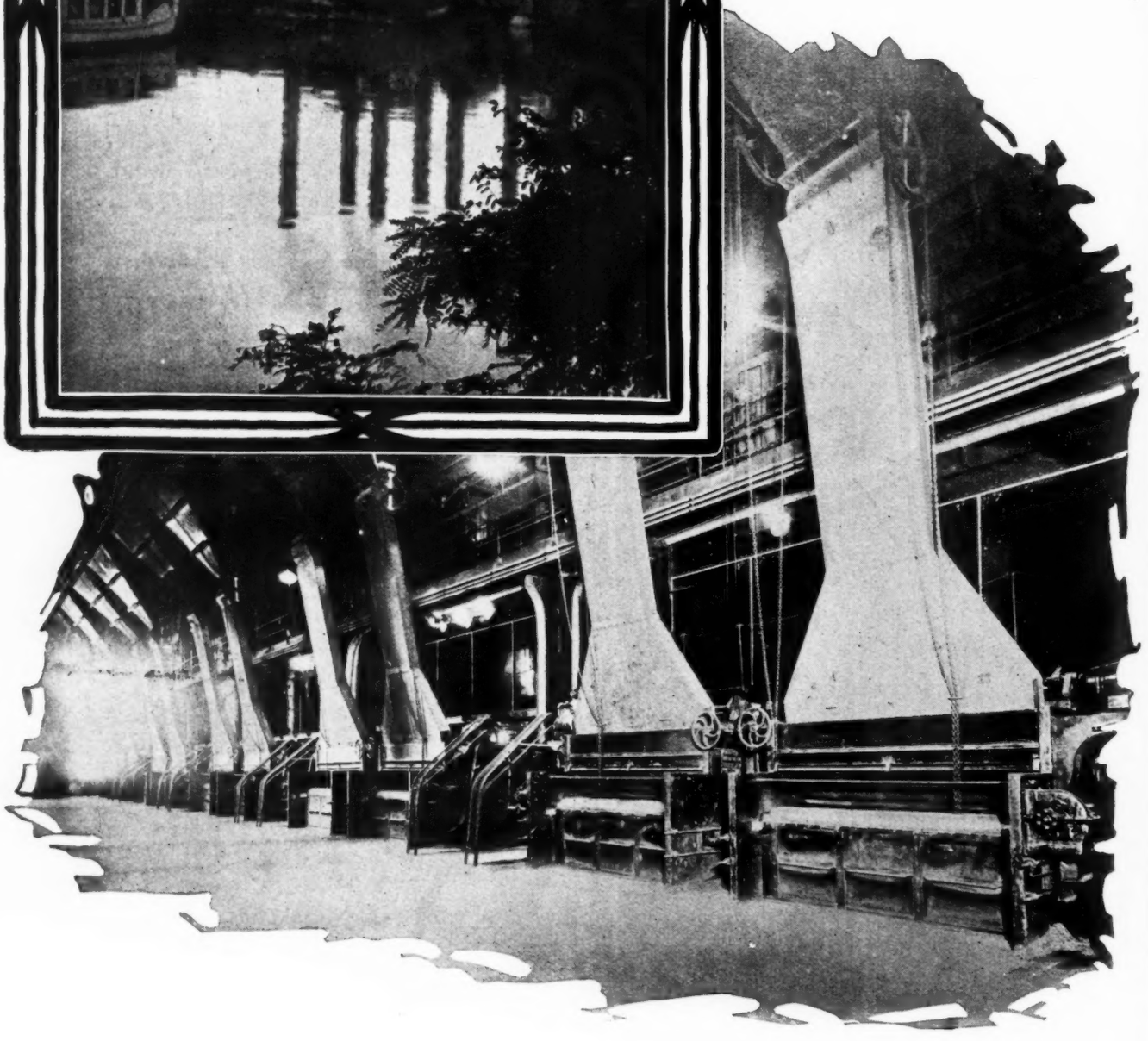
Ship to .....

Address ..... Position.....

.....ed.....

In the big





"Northwest Station"

of the Commonwealth Edison Co.

THERE was a demand for more steam at the Northwest Station of the Commonwealth Edison Co., Chicago.

Ten new and highly developed Illinois Type G Forced Draft Chain Grate Stokers with dampered air control were selected to meet this demand.

Higher efficiencies and generally better results from the poor grade of coal used at this station were determining factors.

The Illinois Stokers installed in this famous plant have seven zones of equal length, spaced on 24-inch centers. Inverted V-type cast iron hopper bottom tuyeres are used instead of steel tuyeres.

The bottom edges and end joints of each compartment, as well as the cast iron doors that extend the full width of the stoker are *machined* to give an absolutely air tight compartment. Operating shafts extend to the outside where, by means of a lever, segment, and retaining dog, each door is held tight.

When each door is opened, the small amount of accumulated drippings in the respective compartments is deposited on the upper surface of the returning chain from where it is carried forward and discharged at the front of the stoker as the chain rotates around the front driving sprockets. This simple arrangement eliminates the necessity of manual removal, and eliminates the dust and dirt that is unavoidable with the latter method. Further the cast iron tuyeres have much longer life than the steel.

The Illinois Stoker links are only $\frac{3}{4}$ in. in width—they are slotted on one side and across the top of the link so that the entire surface is an active burning area. Vertical baffles along the sides of the links prevent air from traveling along the chain. Additional baffles under the ends of adjacent links prevent drippings from falling thru at this point.

Each zone is *regulated* through hand controlled dampers whose positions determine the volume and pressure of air for each zone.

The actual value of the above method of dampered air control is conclusively demonstrated by the fact that analysis of the gases of combustion in the first pass of the boilers over long periods of operation show from 13% to 15% CO_2, with an average of 14%. These figures are obtained at ratings at from 220% to 240%.

A new type of worm sector and hand wheel provides for a fine adjustment of the gate opening.

The drive consists of a double worm and gear fully enclosed reduction, direct connected to the stoker drive shaft and belted to a 3 HP, 230 volt DC motor. This motor is equipped with a controller that allows a grate speed range of from 3 inches to 12 inches per minute.

The foregoing are not only the features of the stokers in the Northwest Station—they are the outstanding advantages of all Illinois Forced Draft Stokers.

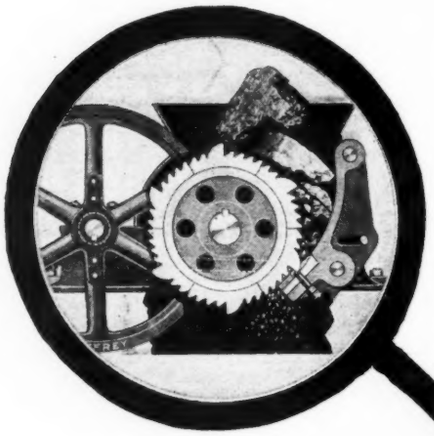
The new edition of catalog "L" outlines the many advantages of both the Illinois Natural and Forced Draft stokers. It will be mailed upon request.

Illinois Stoker Co., 104 W. 7th St., Alton, Ill.

Chicago: Ernest E. Lee Co., 115 So. Dearborn St.
Kansas City: J. F. Pritchard & Co 419 Reliance Bldg.
Minneapolis: W. P. Nevins Co. 120-122 S. Ninth St.
New York: H. G. Meissner 141 Broadway
Denver: A. B. Kennedy 1265 Humboldt St.

ILLINOIS CHAIN GRATE STOKERS
With Dampered AIR CONTROL

An Essential Unit That Guarantees A Constant Supply of Properly Sized Stoker Coal



Every one prepares against emergencies—by life or fire insurance, spare tires, safety valves, sprinkler systems, etc. The greatest emergency for a stoker-equipped boiler plant is the shortage of properly sized coal.

No Matter What Stoker You May Have Installed

The JEFFREY SINGLE ROLL CRUSHER

will reduce Run-of-mine or Lump Coal, in One Operation, to a size which will give maximum heat efficiency.

More than 2000 plants are profiting by the use of the Jeffrey Single Roll Crusher. Why not make your Plant independent of the screening handicap?

Write for Catalog No. 359-A.

The Jeffrey Manufacturing Co.
932-99 North Fourth St., Columbus, Ohio

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CHUSE ENGINES

YOU can search as far as you like for an example of a perfectly functioning piece of mechanical equipment, but you cannot find one so nearly perfect as a modern steam engine—particularly if it bears the name Chuse.

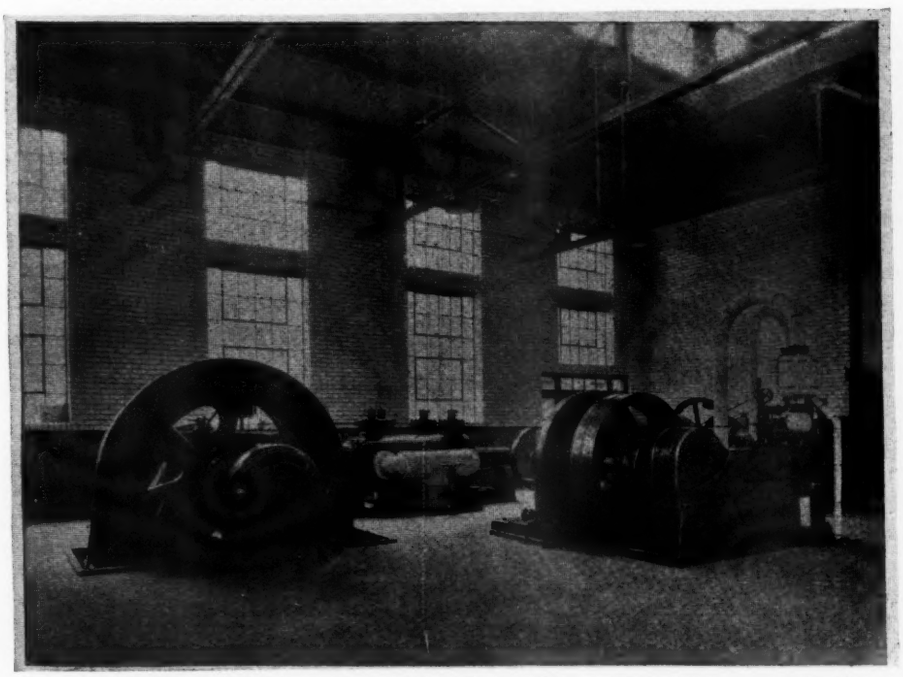
Here is a man-made device that can scorn the frailty of its maker—a device that runs noiselessly and dependably through countless generations of men—a device that seems to have found eternal youth.

But the operators of today have come to assume this high standard as a matter of course—and to measure engine worth, not by mere ability to keep going year after year, but by the signs of refinement that set *some* engine above and apart from the many *good* engines.

Operators of this type have found a still higher standard for engine performance in the Chuse Uniflow—standard bearer for the Chuse series. The indicator card of a new Chuse Uniflow pronounces it all-but-perfect — and the indicator card taken years afterwards will prove that it is still as good, as efficient, as economical as the day it was installed.

Chuse Engines are made in a full range of sizes from 50 to 1800-hp., single valve, non-releasing Corliss and uniflow types. Ask for catalog—but don't forget to ask a user, too. It may be your final reason for selecting a Chuse Engine!

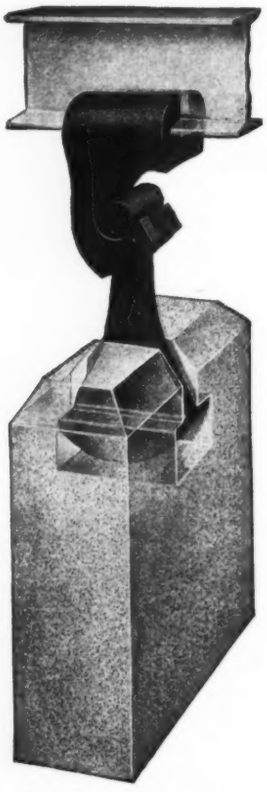
CHUSE ENGINE AND MANUFACTURING CO. OFFICES AND WORKS: MATTOON, ILL.



One—23 x 28, 480 i.hp. Chuse Non-condensing Uniflow Engine and One 14x17, 160 i.hp. Non-releasing Chuse Corliss Engine in power plant of Bridge and Beach Mfg. Co., St. Louis, Mo.

The McLeod & Henry Flat Suspended Arch

—with exclusive features for better efficiency and greatly reduced maintenance costs



Typical block and unit suspension of McLeod & Henry Arch.

HERE is the arch you have been waiting for — readily adaptable to any boiler, metallurgical or other furnace and providing for correct gas distribution, through combustion, smoke prevention and as quick fuel ignition at the feeding end as in the rest of the furnace.

Following are 15 good reasons why the McLeod & Henry Arch should be entitled to the preference. Make a point-by-point comparison and your own judgment will tell you that our construction is decidedly superior.

1. Simplest safe suspension ever offered. Nothing but plain I-beams and interchangeable individual hangers. No bolts, nuts, spacers, etc. Beams are permanently set on steel plates in the boiler wall. No intermediate beam hangers with open end as are used where a whole row of blocks has to be slid onto a single fitting.
2. No outward thrust on furnace walls, therefore no outward bulging and no skewbacks, buck stays or tie rods.
3. Each block in main part of arch is independent, independently suspended, standard, interchangeable and removable *from underneath and without disturbing I-beams, brick work or any other block.* Partial or complete replacement or repair of blocks is far easier than with any other construction.
4. Blocks hang *straight down* regardless of pitch of arch. No sticking of a block being removed, as the others merely rest against it but do not impose any of their weight to exert a clamping action.
5. Smooth even bottom. Blocks of arches with slope have their bottoms beveled to make flush contacts with each other at the fire surface.
6. Blocks made from "Steel Mixture" which in the form of furnace side-wall lining, boiler-door arches, baffle tile and standard fire brick has for over 50 years maintained an enviable reputation in resisting the highest furnace temperatures.
7. Harm from expansion is impossible. Each block and the whole assembled mass are free to move laterally in every direction and as the front and side edges of the arch are joined to the boiler walls only by a loose asbestos wool cushion, both the arch and the boiler walls can expand and contract without effecting each other.
8. Gas-tight without grouting between the blocks. The products of combustion soon seal the voids and the asbestos cushions seal the junctures with the boiler walls.
9. Rear end with rounded or other contour to facilitate gas flow made possible by special blocks and suspension devices.

STEEL MIXTURE
REG. U.S. PAT. OFF.

These are made in ample variety and can also be formed into auxiliary front arches for deflecting heat from the fronts of stoker-fired boilers.

10. Apron walls or other superimposed brick work may be built over the end blocks with perfect fit, yet without impairing removability of the arch and end blocks.

11. Design flexibility and individual engineering (the latter without extra charge) assure that each application is correct for the work it must do. The width, depth, pitch and end construction are specially adapted to the furnace dimensions, kind of fuel, draft and method of firing.

12. Installation simple and may be made by any one of ordinary intelligence. Parts can't be assembled wrong, and an expert is not required to erect the setting.

13. Long life and low maintenance. The blocks are very durable. The suspension is out of hottest gases and where easily inspected. Ventilation may be employed as an extra protection against burning out and distortion.

14. Renewal parts always quickly obtainable from a large stock always on hand.

15. Liberal guarantee on material, workmanship and performance.

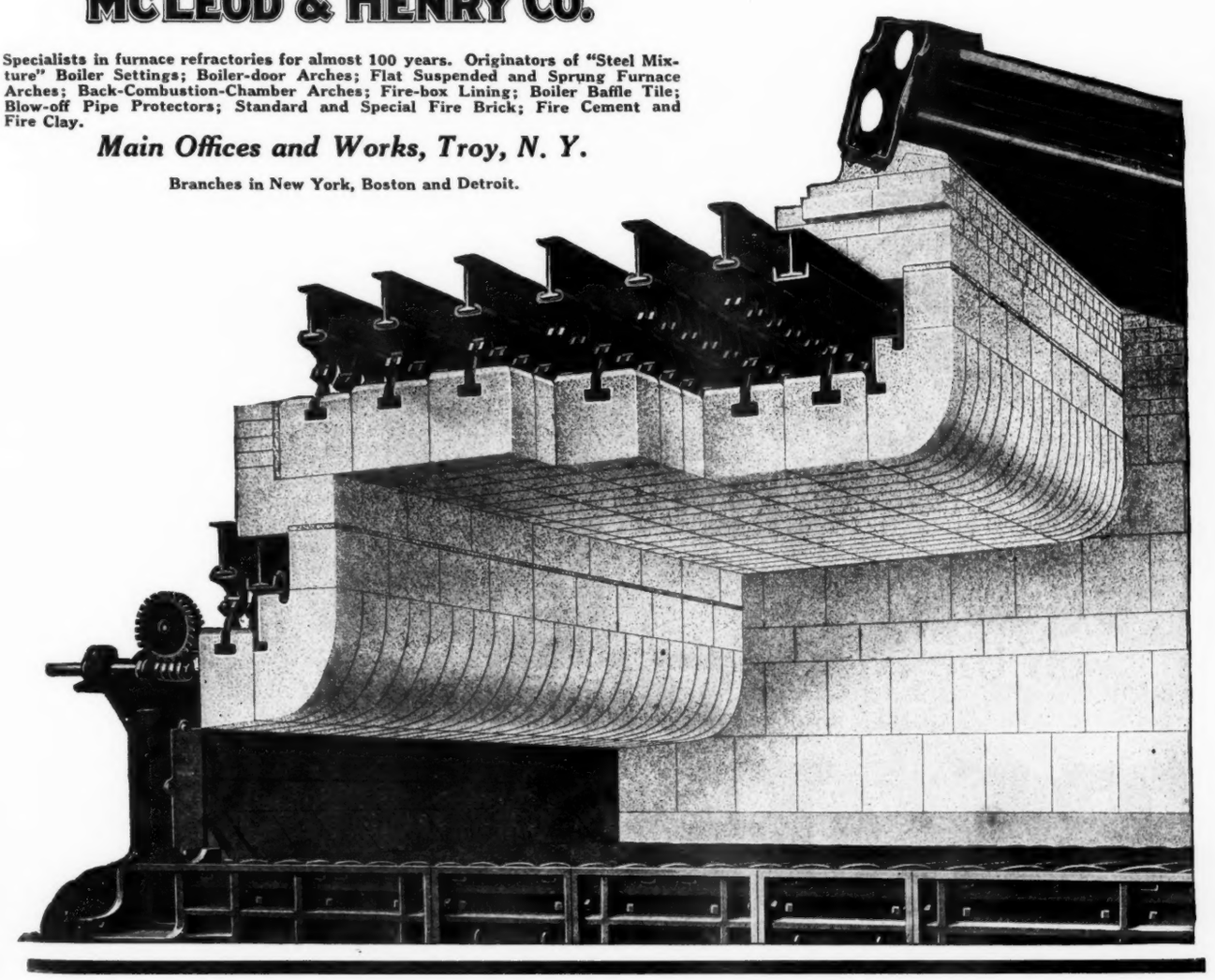
Write for Bulletin 155 P and if you want specific information tell us make and h.p. of boiler, kind of fuel used and inside width of furnace.

McLEOD & HENRY CO.

Specialists in furnace refractories for almost 100 years. Originators of "Steel Mixture" Boiler Settings; Boiler-door Arches; Flat Suspended and Sprung Furnace Arches; Back-Combustion-Chamber Arches; Fire-box Lining; Boiler Baffle Tile; Blow-off Pipe Protectors; Standard and Special Fire Brick; Fire Cement and Fire Clay.

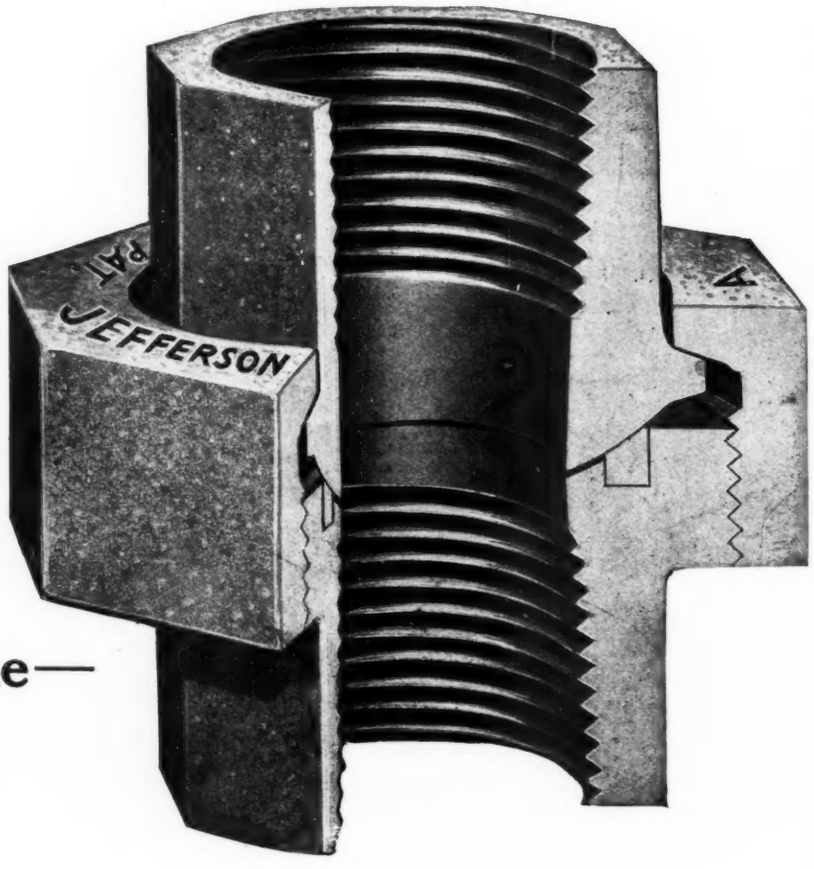
Main Offices and Works, Troy, N. Y.

Branches in New York, Boston and Detroit.



The Dominant Un

The Dominant Union—for six leading reasons—simple reasons that practical men have proved by the acid test of actual service. If you are not now using Jefferson Unions, get a few from the nearest jobber and put our statements to the proof.



Try them
and
Look for the Name—
—where?—
on the Nut!

The Union of Str

Union-Jefferson

Here are the six reasons that tell the story—

1.—The brass seat ring is inserted in a channel away from the runway, and is not affected by the contents of the pipe.

2.—The male and female parts are ground together after which they are never separated, thus insuring absolutely tight and self-seating joints.

3.—The sloping shoulder and the play in the ball end is convenient, especially when connecting pipe slightly out of line.

4.—The pipe threads are tapped with Briggs' Standard Taper Pipe Threads.

5.—The nut threads are coarse enough to permit rapid adjustment.

6.—The JEFFERSON Union is the heaviest of its class on the market, and is sold at a reasonable price.

JEFFERSON UNIONS

The Jefferson Union Co. Lexington, Massachusetts.

Strength-Jefferson

Where does th

The tools of power plant cost accounting

The Republic Integrator. Makes an integration of the steam flow through the line that it is metering. Because of electrical operation, may be located on central panel board. Allows evaporation per pound of coal fired to be easily computed. Measures consumption of departments.

The Republic Indicator. A constant guide to the fireman—acts instantly. Points out the boiler that is laying down and prevents fireman from passing the buck.

The Republic Recorder. Gives a 24 hour graph of steam output from one or a battery of boilers. May be located on central panel board in chief's office.

REPUBLIC
Pioneer Electrically Operated
FLOW METERS

Republic System

Republic Flow Meters Co., 2222 Diversey Parkway, Chicago.

I am interested in Power Plant Cost Accounting. Please send me the bulletin.

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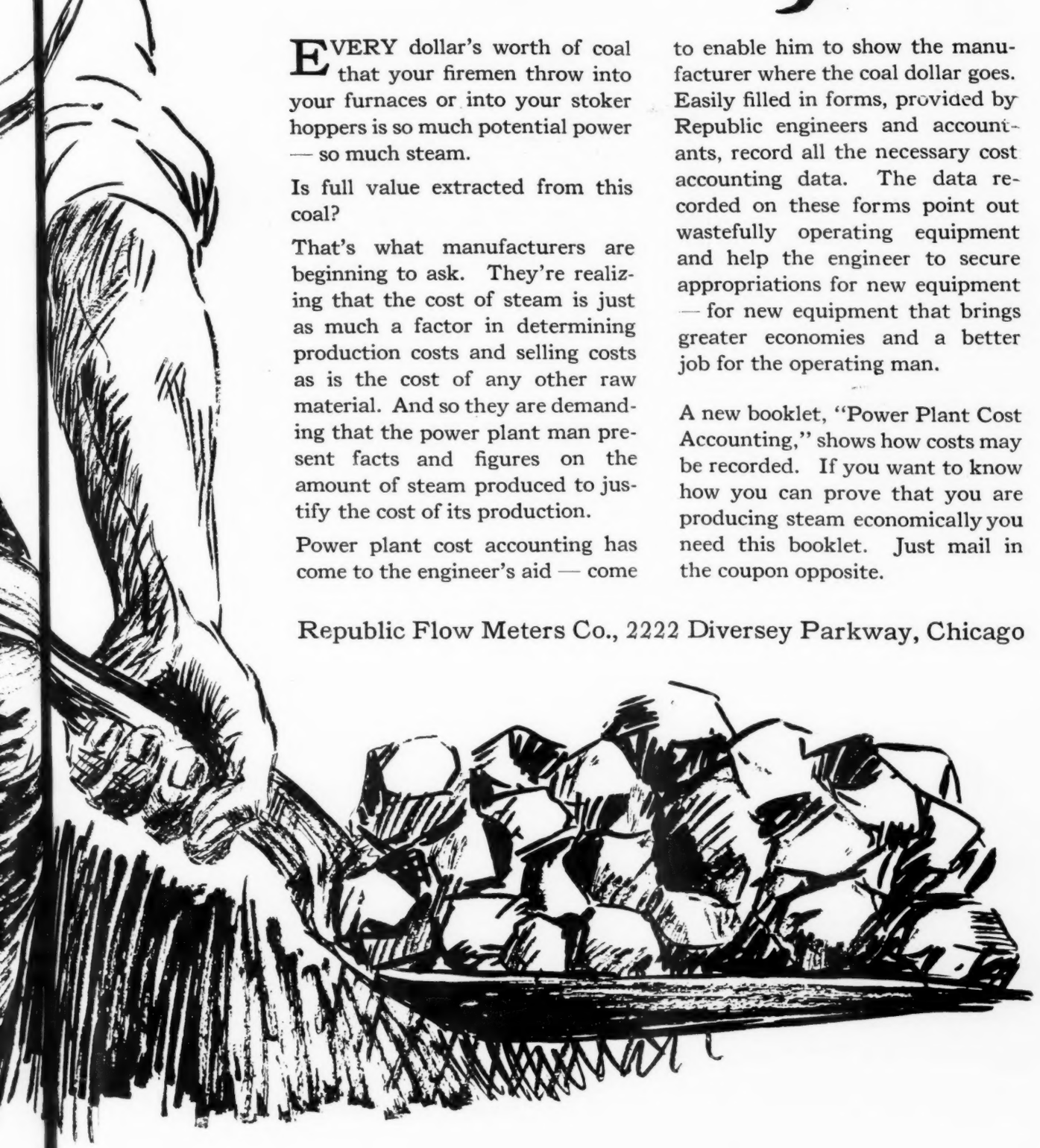
P-6-26-23

s the coal dollar go?



EVERY dollar's worth of coal that your firemen throw into your furnaces or into your stoker hoppers is so much potential power — so much steam.

Is full value extracted from this coal?

That's what manufacturers are beginning to ask. They're realizing that the cost of steam is just as much a factor in determining production costs and selling costs as is the cost of any other raw material. And so they are demanding that the power plant man present facts and figures on the amount of steam produced to justify the cost of its production.

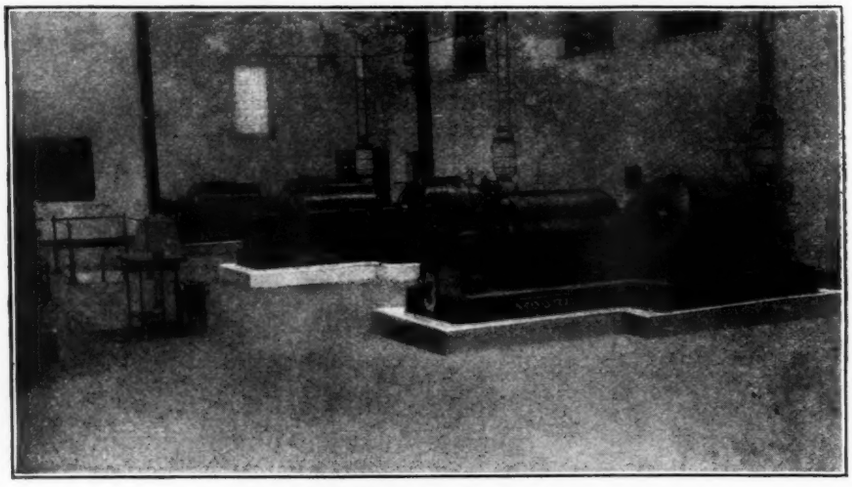
Power plant cost accounting has come to the engineer's aid — come to enable him to show the manufacturer where the coal dollar goes. Easily filled in forms, provided by Republic engineers and accountants, record all the necessary cost accounting data. The data recorded on these forms point out wastefully operating equipment and help the engineer to secure appropriations for new equipment — for new equipment that brings greater economies and a better job for the operating man.

A new booklet, "Power Plant Cost Accounting," shows how costs may be recorded. If you want to know how you can prove that you are producing steam economically you need this booklet. Just mail in the coupon opposite.

Republic Flow Meters Co., 2222 Diversey Parkway, Chicago

MOORE

"Best at Every Turn"



3—500 K.W. Moore Turbo Alternators

MOORE MAKES SUGAR at Sagua La Grande, Cuba

"Entirely satisfactory," say the owners.

The three 500 K.W. Moore turbo alternators have been in continuous operation for about two years—serving the town of Sagua La Grande, Cuba, together with several sugar centrals. Their excellent service, far away from home, is worthy of comment.

There has never been one moment's delay—**DEPENDABILITY** was the keynote of the original purchase—a feature of Moore machinery which explains the reason for the large number of Moore units being installed both here and abroad by concerns who demand **the best.**

Investigation of Moore advantages will usually result in the use of Moore machinery with a degree of satisfaction heretofore unknown.

Turbines all types 5 to 1,500 H.P.
Turbo Pumps and Blowers.

Turbo Generators up to 1,000 K.W.
Double Herringbone Reduction Gears.

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Large Clearances
Low Speeds
Safe Stresses
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Horizontally Split Casings and Diaphragms
High Steam Economy
Low Steam Velocities
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Simple Design—Honest Construction

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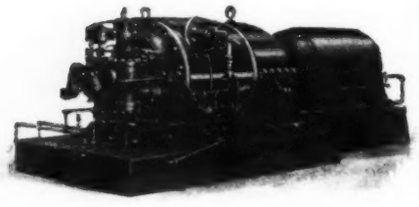


Moore Bleeder Turbine

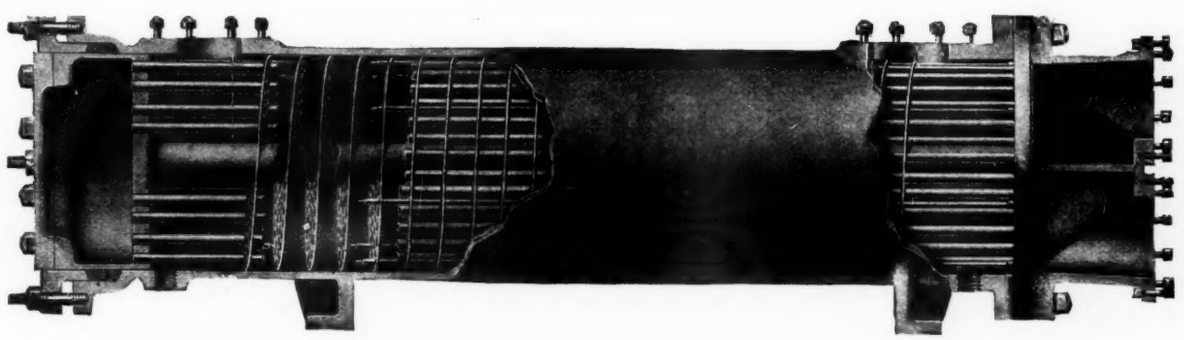
"Makes Power a By-Product"

Needed in every industry where exhaust steam is utilized.

2000 In Service

for cooling turbine, transformer and quenching oils and for process work involving heat exchange between liquids.

MULTIWHIRL COOLERS



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The Griscom-Russell Co.,
2116 West Street Bldg.,
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Gentlemen:
Please send copy of your Bulletin No. 904 describing Multiwhirl Coolers.

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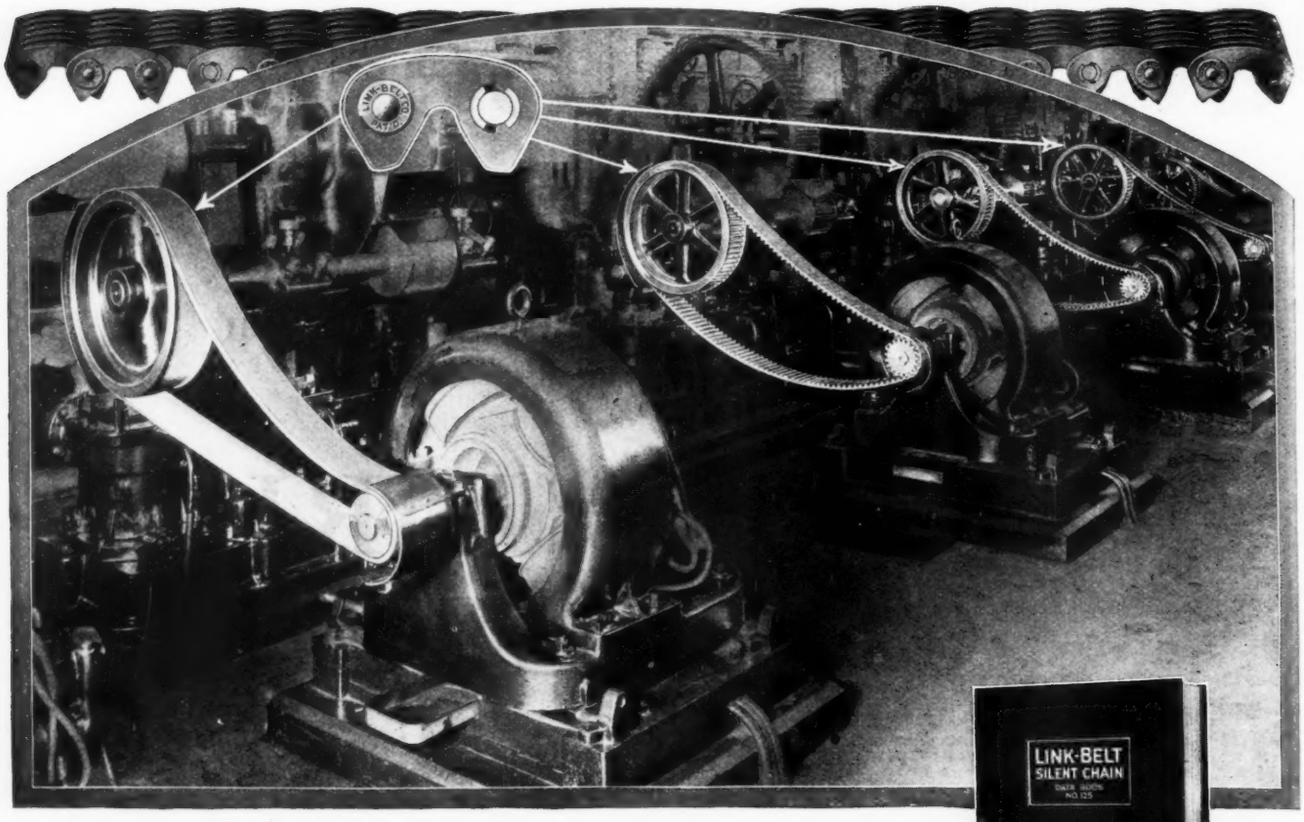

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Link-Belt Silent Chain—a part thereof

For years Marshall Field & Company, Chicago, have employed Link-Belt Silent Chain Drives to operate their Deane pumps which furnish water supply for the entire store.

In addition, their Blower System, Vacuum Pumps, etc., have been Link-Belt Silent Chain operated for over ten years.

Just another example of reliability—efficient service—and in a store renowned for buying and selling *quality*.

Our Data Book No. 125 is a handbook on silent chain practice—not a catalog. It shows how to figure drives and determine prices. Send for it. Return the coupon.

LINK-BELT COMPANY
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SILENT CHAIN DRIVES

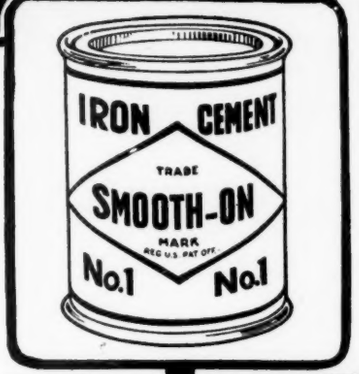
If it's a Power Plant Repair it's in the SMOOTH-ON INSTRUCTION BOOK

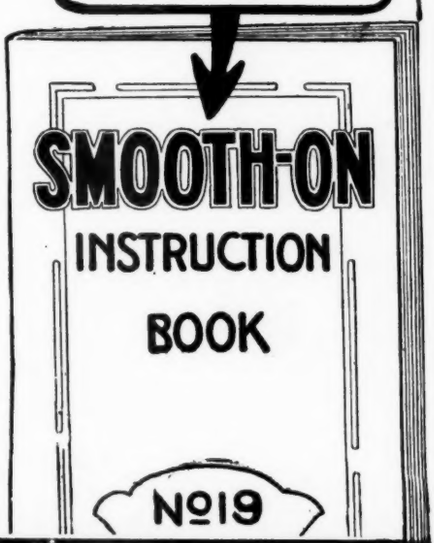
TWENTY-FIVE years ago Engineers began to prove our claims for SMOOTH-ON Cements in new installation and repair work. "You're right," said one Engineer, "I did *this!*" "You're right," said another, "I did *that!*" and they told us all about work they had done quickly, and cheaply, and permanently, with SMOOTH-ON Cements.

Instruction Book No. 19, recently issued, is the latest and best of a series of SMOOTH-ON Books. It covers the entire range of breaks, cracks and leaks met in Power Plant work, and other matters of interest to Power Plant Engineers. Over 100 typical repair and installation jobs are covered and 77 Engineers tell in your language just how each was done.

144 pages; 80 halftone engravings from actual photographs; 51 diagrams and drawings illustrate every vital point. As a service to Engineers we are glad to send Instruction Book No. 19 FREE to any Engineer who asks for it. Your copy is waiting. The coupon or a post card will place it in your hands.

SMOOTH-ON Cements are sold by Supply Houses in 5 lb., 10 lb., and 25 lb. tins; also in larger sizes.





Smooth-On Mfg. Co.,
Dept. 30-Z, Jersey City, N. J.

Gentlemen:—Kindly send me a free copy of Instruction Book No. 19, as per your June 26th advertisement in Power.

Name .....

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SMOOTH-ON MFG. CO.
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Jersey City, N. J., U. S. A.

If your Supply House does not carry SMOOTH-ON Cements, send us their name and we shall see that you are supplied.

Do it with SMOOTH-ON

Architects and Engineers

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THE GOVERNMENT SELECTED

Keasbey & Mattison's "Featherweight" 85% Magnesia

to cover ALL the hot pipes on the

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Because it was

"The Best by Test"!

Then the Bureau of Engineering

proved by its tests

at the Annapolis Laboratories that the

Keasbey & Mattison Co.'s "Featherweight" 85% Magnesia

made with Carded Asbestos Fiber, was

SUPERIOR TO ALL OTHER COVERINGS

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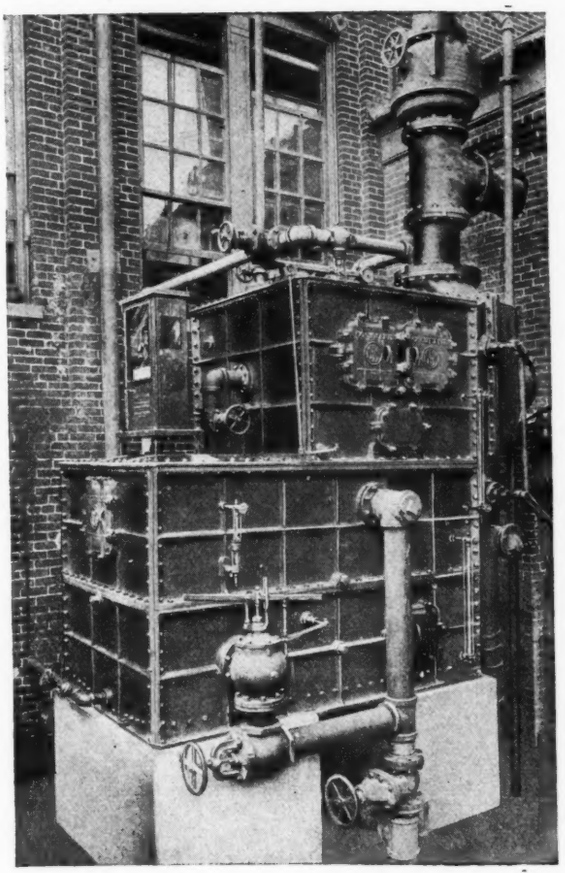

Feed Water Meter

In Connection With Exhaust Steam Heating System

THE COCHRANE METERING HEATER of the Steam Stack and Cut-out Valve type shown herewith is used in connection with engines exhausting against back pressure. It is fitted with an extra large separator, of capacity sufficient to purify the entire amount of exhaust steam, including that used in the heating system as well as that passing into the heater itself. By throwing the handle which operates the valves in the separator and in the trap the heater can be cut out of service for cleaning or inspection while the separator continues to supply oil-free steam to the radiators.

The Cochrane Multiport Back-Pressure Valve, by which the back-pressure is controlled, may be seen in the exhaust line above the branch to the heating system.

The Cochrane Metering Heater operates perfectly under back pressure conditions, since the heating chamber is equalized with the metering chamber. The latter can, however, be cut out of circuit by closing two valves and the feed water will then be by-passed directly from the heater chamber to the boiler feed pump, so that the meter can be opened or adjusted without interfering with the heater.

Similarly, the apparatus can be so arranged that the meter can be kept in operation while the heater is being opened for cleaning or other attention.

The Cochrane Metering Heater is guaranteed to be accurate within 1½% of actual weight, temperature variations not exceeding 25 degrees. An outside zero pointer provides for adjusting the recorder to zero at any time, even when the apparatus is filled with hot water and without opening the meter chamber.

The Cochrane Metering Heater is generally accepted by leading engineers as the most satisfactory means of measuring boiler feed water and has been installed in the leading plants throughout the country, and in all capacities up to and including 30,000 boiler H.P.

The popularity of the Cochrane Metering Heater arises from its greater accuracy at all loads, including small fractional loads, and the fact that it improves the thermal efficiency directly, by utilizing exhaust steam to heat the boiler feed water up to 212 degrees or hotter, depending upon the back pressure carried. This is in addition to the valuable information which it gives as to the benefits following cleaning boiler heating surfaces of soot and scale, repairing furnace walls and baffles, changes in fuel or in firing methods, etc.

If you are interested in the heating, metering or softening of boiler feed water, give us your address so that we may send a copy of our new book "L" on that subject.

H. S. B. W. - COCHRANE CORPORATION

Formerly Harrison Safety Boiler Works

17th and Clearfield Streets Philadelphia, Pa.

Also at Atlanta, Baltimore, Birmingham, Boston, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Greenville, South Carolina; Hazleton, Pa.; Houston, Indianapolis, Kansas City, Little Rock, Los Angeles, Minneapolis, New Orleans, New York, Pittsburgh, Richmond, Rochester, St. Louis, Salt Lake City, San Francisco, Seattle, Syracuse, Tucson, Toronto, Montreal, Halifax.

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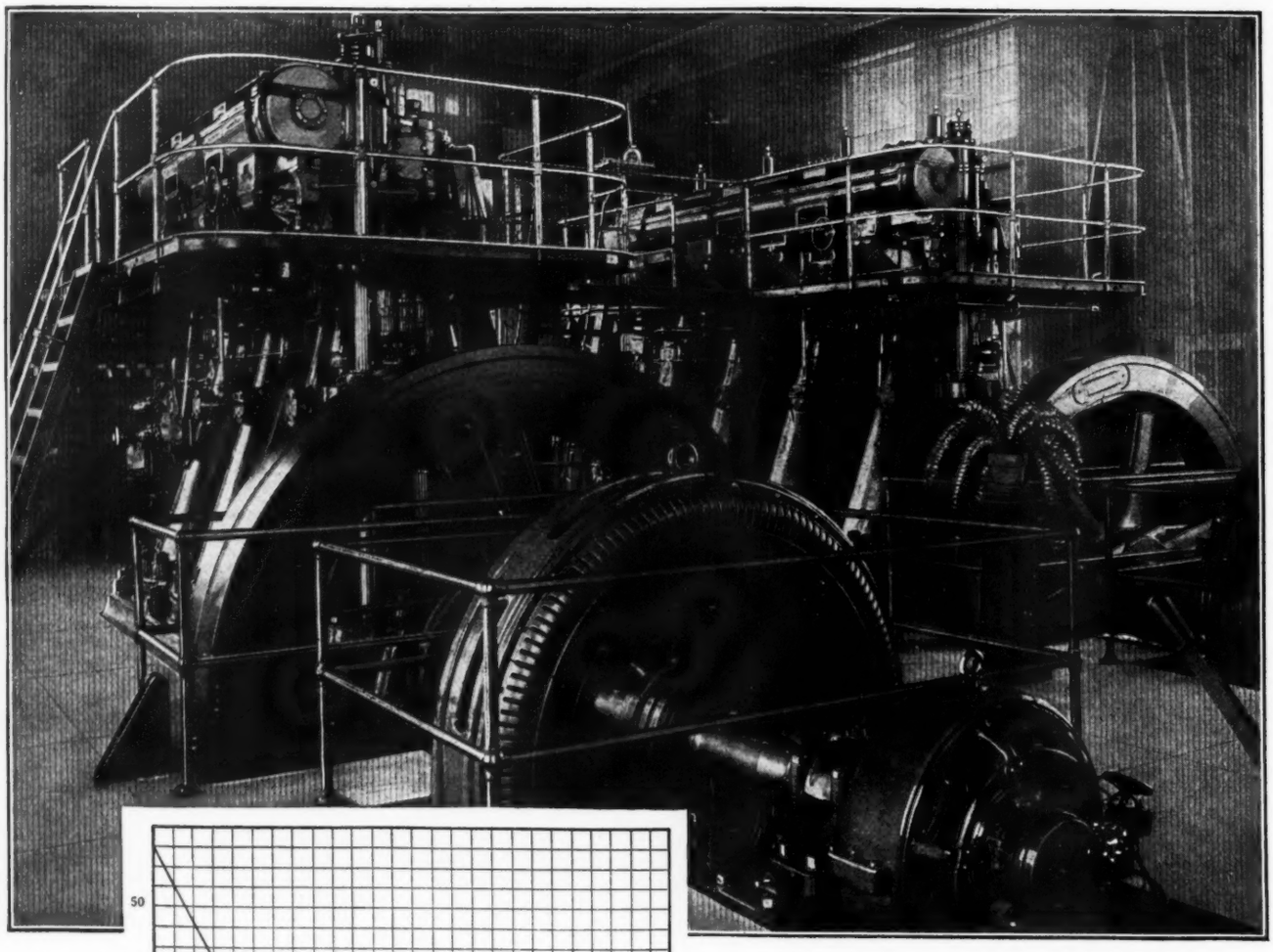
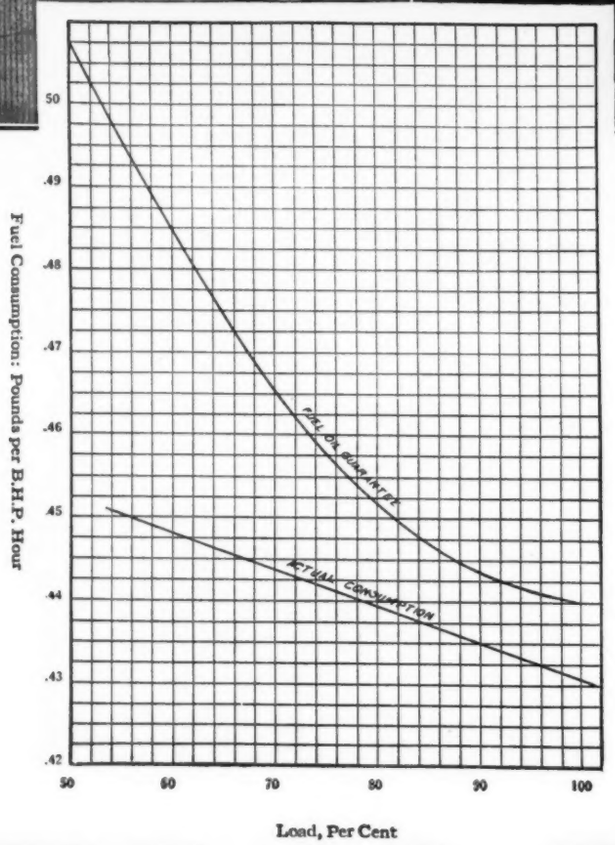
"TO ECONOMIZE-COCHRANIZE"



The 285 and 380 h. p. Fulton-Diesels installed at Crowley, Louisiana.



The above chart illustrates the almost constant low fuel consumption of the Fulton-Diesel, irrespective of load. And the high efficiency may be maintained indefinitely, so long as the engines receive reasonable mechanical attention.

FULTON

"A Good, Safe Margin Between Performance and Guarantee"

This statement, relating to fuel consumption, is taken from the report of the engineer making the Acceptance Test on the two Fulton-Diesels — of 285 and 380 h. p. — recently installed in the Municipal Central Station at Crowley, Louisiana. The readings on the chart show how safe this margin was—particularly at the lower loads.

Starting with fuel economy proved, these engines, during a period of two months this spring, with an average load factor of only 38½%, established a total operating cost of $0.0157 per k. w. h.

Fulton-Diesels Insure Uninterrupted Service

In those industries where you find the highest premium on continuity of operation, Fulton-Diesels have long been giving satisfactory service. They are designed and built to meet the severest operating requirements and, under competent supervision, will maintain continuous high efficiency with surprisingly low upkeep expense.

Back of Every Fulton-Diesel

is over seventy-one years of successful engine building. Behind every installation is the guarantee of Fulton service which includes regular visits from supervising engineers who advise concerning the most efficient Diesel engine practice.

Regardless of location, our engineers will always, without obligation, gladly consult with you on any power problems. Executives and plant engineers are cordially invited to visit our works at any time, and we will welcome the opportunity to send you a copy of our latest booklet describing and illustrating the Fulton-Diesel.

FULTON IRON WORKS COMPANY, ST. LOUIS, U. S. A.

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DIESEL

Standardized High Head Turbines
One of the seven Worthington standardized high head water turbines that cover practically every normal requirement. The Worthington Water Power Equipment bulletin has an interesting story about Standardized Turbines; have you read it?
W-185.4
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We send men and portable tools to your plant to rebore cylinders and ports and fit new pistons and valves. Contract work. Builders of Special Machinery. Send us your requirements.

AMERICAN DESIGNERS AND BUILDERS OF DIESEL ENGINES SINCE 1898

BUSCH-SULZER

STATIONARY 120 TO 3300 B.H.P.
MARINE 600 TO 3000 S.H.P.

BUSCH-SULZER BROS.-DIESEL ENGINE CO., St. Louis, U. S. A.
NEW YORK, 60 BROADWAY SAN FRANCISCO, RIALTO BLDG.

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Uniflow Engines · Corliss Engines · Diesel Engines
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RIDGWAY POWER UNITS
To produce unfailing power economically
Ridgway Dynamo & Engine Co.
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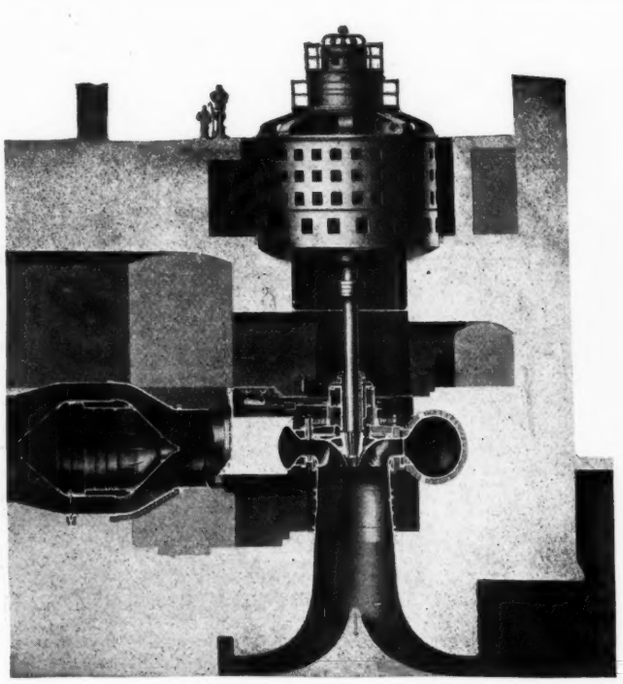
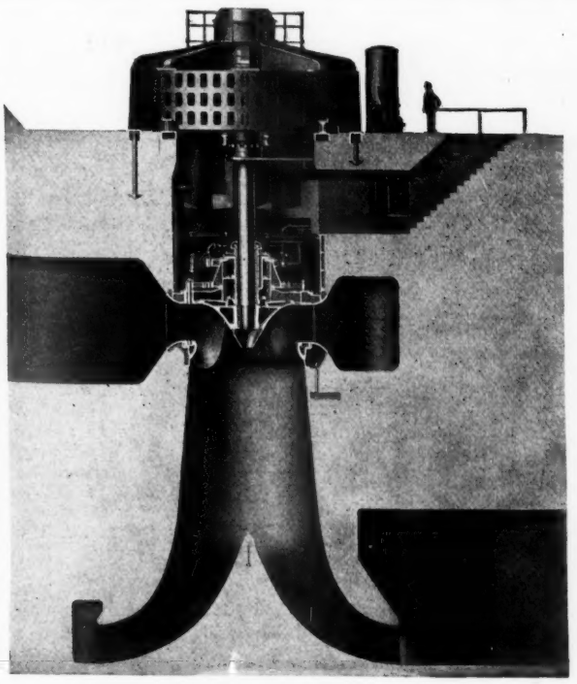
STANDARD DIESEL ENGINE BUILT BY THE HADFIELD-PENFIELD STEEL CO.

THE STANDARD DIESEL ENGINE
Reliable and Economical Power
THE HADFIELD-PENFIELD STEEL CO., BUCYRUS, O.

I. P. Morris Hydraulic Turbines

The Wm. Cramp & Sons Ship & Engine Building Co.
Richmond & Norris Sts., Philadelphia





Some of the Contracts for I. P. MORRIS HYDRAULIC TURBINES awarded since January 1, 1922

MANUFACTURED IN PHILADELPHIA

	No. of Units	Horsepower Per Unit	Head In Feet
Phoenix Utility Company (Powerdale Development)	1	8,700	180
Niagara Falls Power Company (Plant 3-C)	2	70,000	213.5
International Paper Company (Sherman Island Development)	1	10,000	66
Adirondack Power & Light Corp. (Spier Falls Development)	1	9,000	80
General Construction Corp. (Piney Creek Development)	2	11,000	75
Great Northern Paper Company (Anson Plant)	4	1,500	20
Western New York Utilities Co.	1	3,160	79
Washington Water Power Company (Long Lake Station)	1	22,500	168
Pennsylvania Water & Power Co. (Holtwood Plant)	2	20,000	62
Amoskeag Manufacturing Co.	1	7,500	45

MANUFACTURED IN MONTREAL

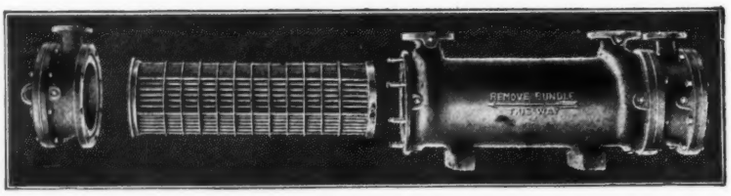
	No. of Units	Horsepower Per Unit	Head In Feet
Manitoba Power Company (Winnipeg River Development)	2	28,000	56
Lower Sturgeon Power Company	2	4,000	42
Maine & New Brunswick Elec. Power Co.	2	2,000	85
Dryden Paper Company, Limited	1	1,400	29
Spruce Falls Company, Limited	1	2,500	25
East Kootenay Power Company	2	7,500	190
Northern Ontario Light & Power Co. (Matabitchouan Plant)	4	3,300	305
Montreal Light, Heat & Power Cons. (Cedars Plant)	4	11,300	30
Montreal Light, Heat & Power Cons. (Cedars Plant)	2	1,500	30
Price Bros. & Company, Limited	1	11,000	72
Howard Smith Paper Mills, Limited	2	350	8
Hydro-Electric Power Commission of Ontario (Queenston Chippewa Development)	3	58,000	294
St. Maurice Power Co.	4	30,000	60
Rolland Paper Co., Ltd.	1	750	20

723,620 Horse Power to be Delivered by I. P. Morris Turbines Contracted for Since January 1, 1922

I. P. Morris Hydraulic Turbines Installed and under Contract have a total Capacity of 3,397,890 Horse Power

Designers and Builders of the Johnson Hydraulic Valve

ASSOCIATED COMPANIES
THE PELTON WATER WHEEL CO., SAN FRANCISCO AND NEW YORK
DOMINION ENGINEERING WORKS, LTD., MONTREAL, CANADIAN LICENSEES
M. HILPERT & CO., RIO DE JANEIRO, BRAZILIAN LICENSEES



To Cool Your Turbine or Transformer Oil

OIL COOLERS

Highest cooling effect obtained by baffling the oil to flow against the nest of tubes at right angles which subdivides it into many thin streams.

Cold water flows through the tubes, which are securely held at one end in a composition metal header, while the other end is held in a floating head that permits a free movement under expansion. No tube trouble is therefore experienced.

Header joints are outside packed.

In successful operation for many years. Address our Heat Transfer Department for interesting new Treatise on Oil Cooling.

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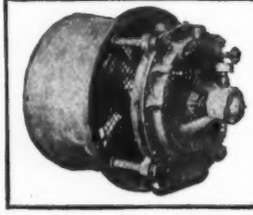

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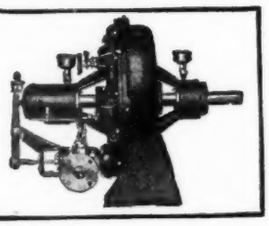
Automatic forced draft for any size boiler. Ideal for stokers or hand fired furnaces.

We specialize in small steam turbines from 1 to 50 hp. for driving circulating pumps, etc.



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Makes All Drives More Efficient and Economical

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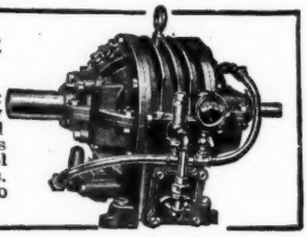

Harrisburg ***For Better Engines***

Dual Clearance Unaflow Engines — **Enclosed Gear Corliss Engines** — **Single Valve Engines**

Write for Bulletins now.

Harrisburg Foundry & Machine Works, Harrisburg, Pa.

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Vertical—18 to 300 H.P.

Self-Contained Gas Engine Driven Gas or Air Compressors save fuel and space

For full data write or wire

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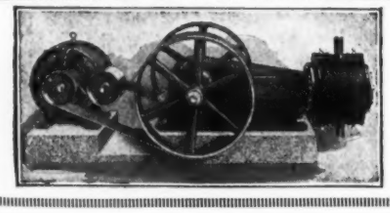

PENNSYLVANIA **Air Compressors and Pumps**

They represent the best practice in their respective class. PENNSYLVANIA Plate Valves on compressors an outstanding feature. Very high efficiency. Quiet, smooth operation. We also build a complete line of centrifugal pumps. Write for Bulletins.

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GENUINE "A"
For Severest Bearing Service

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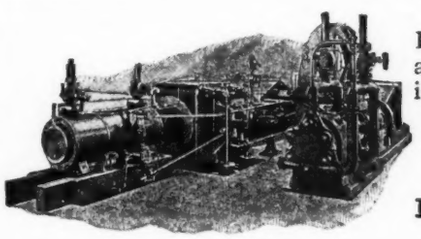

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Poppet Valve Engines

Vilter Tandem Compound Poppet Valve Engine direct connected to Ammonia Compressor.

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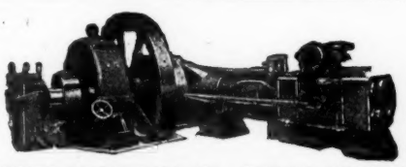

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We will repair any make of engine on the customer's premises. Largest engine repair company in New England. Write.

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Agencies in all sections of the country

AIR COMPRESSORS

All Sizes All Types

No finer compressor made than a Bury Universal Variable Volumn 3-Cylinder, 2-Stage Air Compressor. Why not investigate?

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Stumpf Una-Flow Engine Co., Inc.

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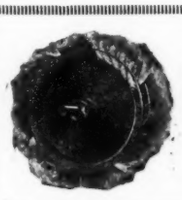
STUMPFLOW DESIGNS—Economical Engines

Let Us Study Your Power Problems—Write Now



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is ideal for driving generators, pumps and fans for all service, because of its simplicity, efficiency and reliability. There are more than 4000 in operation.

THE TERRY STEAM TURBINE CO.
HARTFORD, CONN. T-434

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Steam Turbines, single and multistage, geared and direct connected, and for belt and rope drives; for all steam conditions; capacities up to 15,000 Hp. Catalog D40.
Double Helical Speed Reducing Gears for high speed service. Catalog G40.
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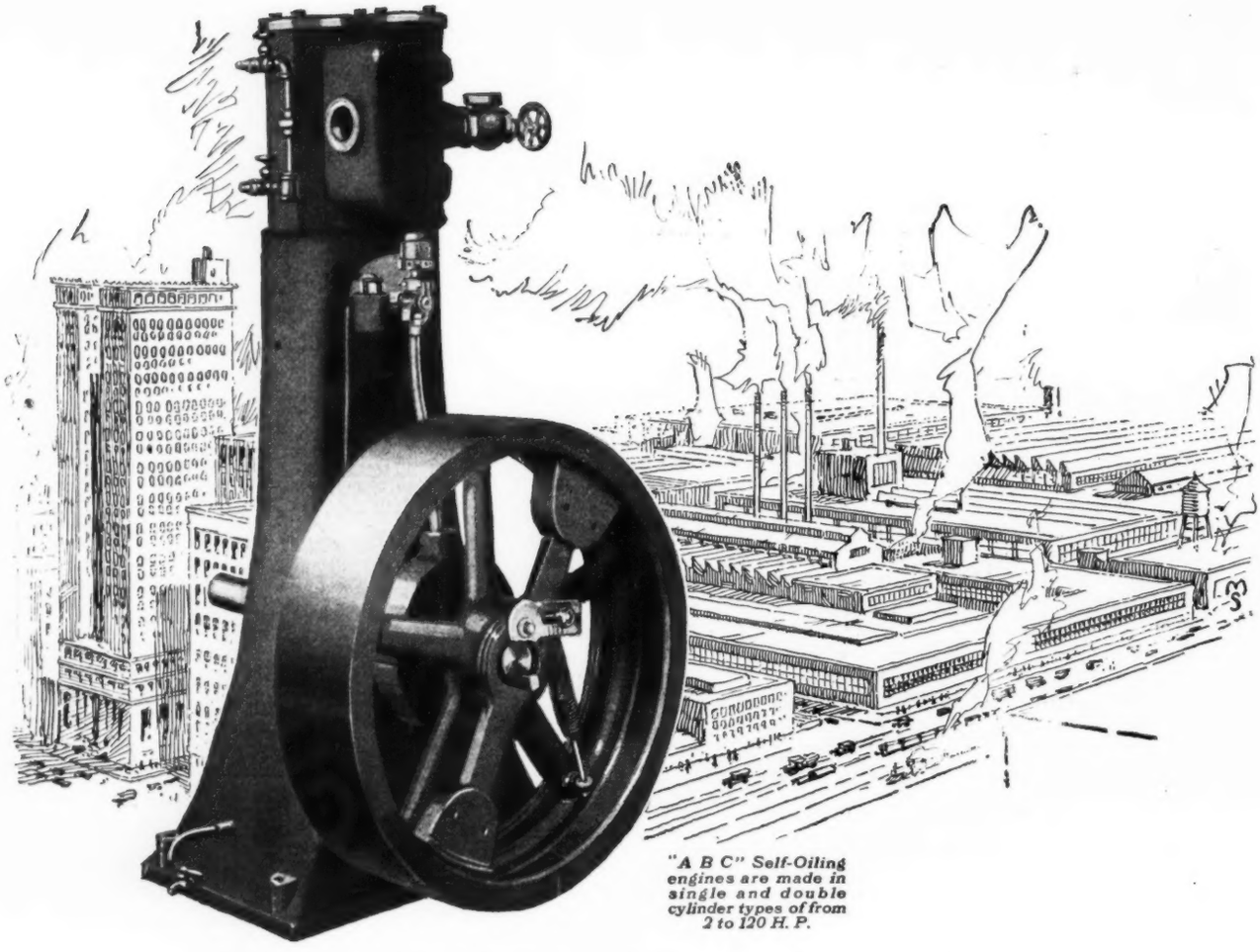
Trenton, New Jersey



"A B C" Self-Oiling engines are made in single and double cylinder types of from 2 to 120 H. P.

This Sturdy Engine Gives Unfailing Power for Months Without Attention

It is hard to realize that any steam engine could endure day-and-night operation—seven days a week—for ten, fifteen and even twenty years. Yet such instances are not uncommon in the case of "A B C" Self-Oiling engines.

These remarkable power units are designed especially for the operation of blower fans, mechanical draft apparatus, lighting plants and other uses where stops are days or weeks apart. Ample lubrication under all conditions, rugged construction and high efficiency make the "A B C" engine one of those rare pieces of equipment that you can install and then almost forget.

Write for details of construction and startling testimonials of its wonderful performance.

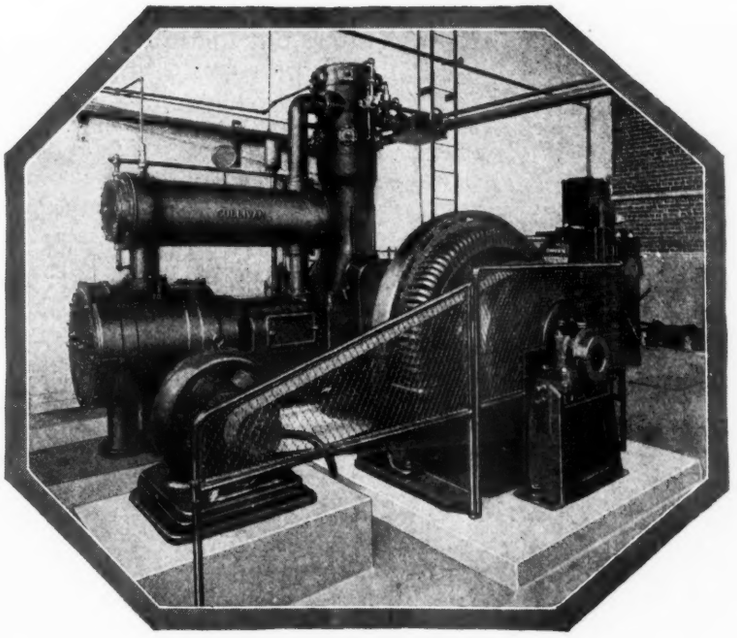
AMERICAN BLOWER COMPANY, DETROIT
BRANCH OFFICES IN ALL PRINCIPAL CITIES
CANADIAN SIROCCO COMPANY, LIMITED, WINDSOR, ONTARIO (276)

American Blower

"Sirocco" TRADE MARK

EXHAUSTERS · VENTILATING FANS · AIR WASHERS · BLOWERS · ENGINES
FOR HEATING, VENTILATING, DRYING, AIR CONDITIONING, MECHANICAL DRAFT

Direct Drive for Angle Compounds



When, to Angle Compound balance, power economy at varying loads and small floor area are added the advantages of direct connected motor drive, the user has a compressed air installation that is nearly ideal.

Compactness, greater efficiency through elimination of belt losses and belt wear, and correction of power factor through use of a synchronous motor, are some of these advantages.

The motor has its own separate bearings and lubrication. "WN-3" Compressors embody the Sullivan unloading system. This requires operation at either full load or at no load, the two most economical points in the cycle. It consists of a total closure unloading device on the air intake, complemented by an atmospheric relief valve which pumps out the high-pressure cylinder when compression stops. Sudden surges of power are avoided.

The power inflow to the compressor is smooth and even at all times.

The Sullivan "WN-3," 1200-foot direct connected unit shown here, is at work in the Enterprise Foundry Company's plant at Detroit, Michigan.

Send for new Bulletin, 777-B.

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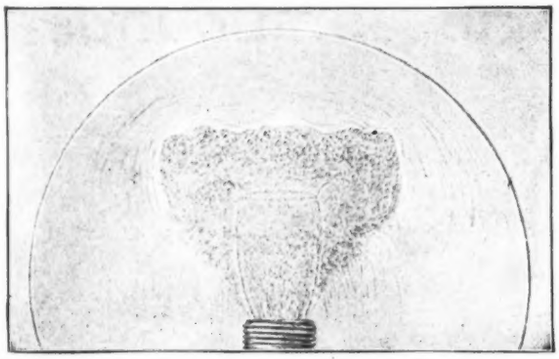

Actual photo of exhaust puff showing noise wave and head of gas column.

The MAXIM SILENCER

filters out the noise wave without interposing back pressure. Made for oil, gas and steam engine exhaust, air compressor and blower intakes and discharges, in all pipe sizes up to 24-inches.

Write for Specification Blue Prints

THE MAXIM SILENCER COMPANY
106 Homestead Avenue, Hartford, Conn.

BOILER TUBES

For Your Plant

Seamless Steel Boiler Tubes

Their use means less tube leakage, less corrosion, safer boilers and fewer tube replacements. They cost less by the year.

Be sure to specify *Pittsburgh Steel Products Co.* when you buy.

Pittsburgh Steel Products Co.
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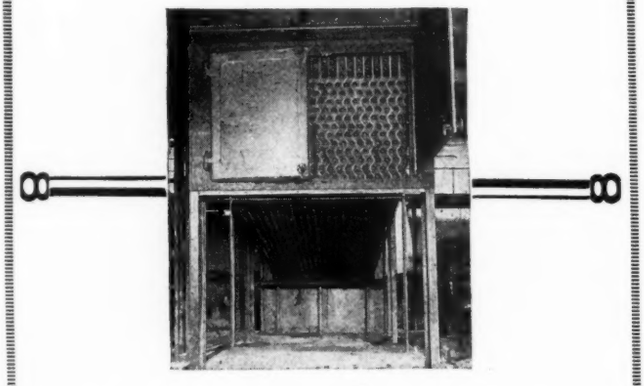

it Meets your Specifications

SUPPOSE you were ordering a special boiler built according to your own conception of an ideal boiler. Could you add anything to the Page Cross-Drum Boiler?

Consider its simple sectional construction, as a result of which any required capacity can be obtained by simply varying the number of standard sections.

Another outstanding feature is the top arch, consisting of I-beams and T-irons which support standard fire-brick and permit an economical and effective construction. Water is taken from the lowest part of the drum, giving better circulation. Ingenious baffling in the drum makes drier steam — these and other features are described in detail in circular which will be sent you on request.

Page Boiler Co., 817 Larrabee St., Chicago

Page Water Tube Boilers

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Let **UNDERWOOD** repair your engines and overhaul your plant. Repair crew and portable tools ready to make emergency repairs day or night in case of breakdown. All work first class by skilled machinists. We carry spare parts in stock. Write, wire or telephone.

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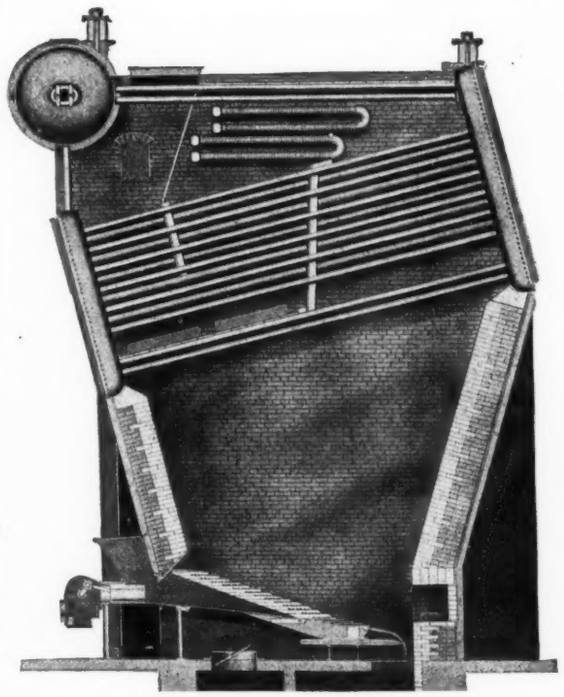
Ammonia Compression **Ammonia Absorption**
CO_2 Compression

Consultation on any Refrigerating Problem Invited.

YORK MANUFACTURING CO., York, Pa.

Wickes Horizontal Cross Drum Water Tube Boiler



The One Joint Header Boiler

A Few Points of Excellence

1. No wrapper sheet in header.
2. No riveted joint on fire side of header or buried in brickwork.
3. The one riveted joint in header visible at all times.
4. All rivet holes in the one joint header drilled from solid plate. All rivets driven with hydraulic riveter.
5. One caulked seam in header and that visible at all times.
6. Vertical fire baffles moulded in place—hence tight.
7. No cast metal used in construction of this boiler.
8. Boiler suspended free from brickwork.

INVESTIGATE!

Ask for Bulletin No. 7 describing in detail—sent free.

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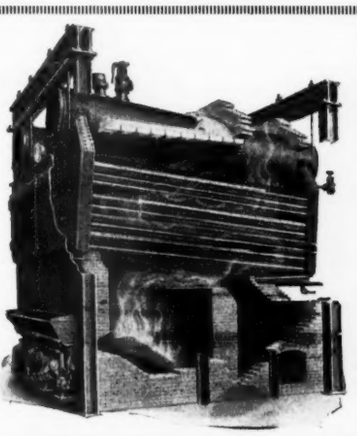
Water Tube Boilers

Large Units for High Pressure

Horizontal Tubular Boilers



8000-hp. Textile Power Plant

The modern textile mill, to compete in the markets of the world, must watch its coal bill. The coal bill depends upon the boiler performance day in and day out, as well as upon the methods used in utilizing the steam.

The plant here illustrated is equipped with automatic scales which weigh every pound of coal that goes into the boilers, keeping an accurate check on the cost of operation and accumulating reliable data which prove the economy of HEINE Boilers. Four 435-b.hp. H-Type HEINE Boilers operating at 200 lb. per sq. in. steam pressure and 100 degrees F. superheat, supply steam to turbines and their auxiliaries totaling 8300 hp. In addition the necessary steam for heating and process work is provided.

HEINE Boilers are designed to facilitate the maintenance of clean heating surfaces and require but minimum time to keep in perfect condition.

Heine Boiler Company—Saint Louis, U.S.A.

HELIOS

The "ECONOMIC"

Has Justified It's Name

Justified it in economy in steam production.

Justified it in economy in first cost.

Justified it in economy in fuel consumption.

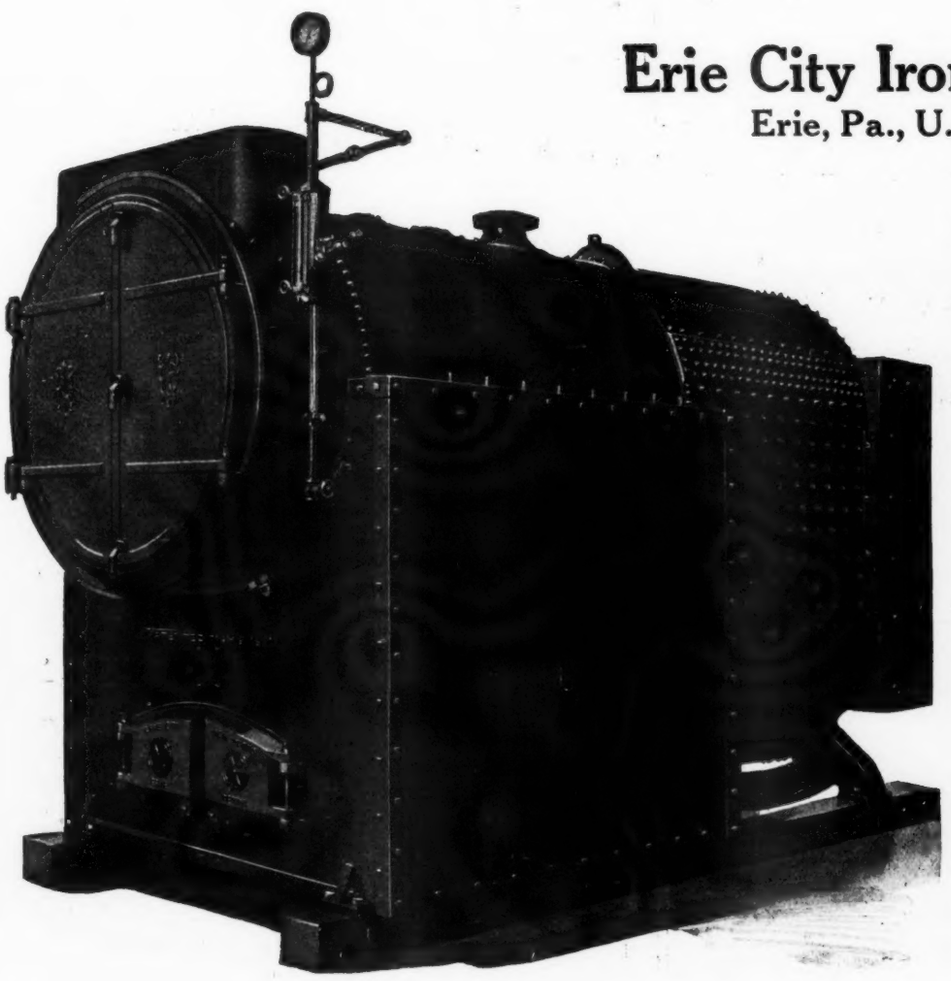
Justified it in economy in upkeep.

Justified it in space requirements.

The "ECONOMIC" is compact and self-contained, and can readily be removed from place to place. In other words, it combines the advantages of the stationary arched boiler with those of the portable. It has been used in hot water heating and steam generation with the most satisfactory results for the past thirty years.

See our "ECONOMIC" Bulletin for further details

The "ECONOMIC" boiler is built in 10 sizes



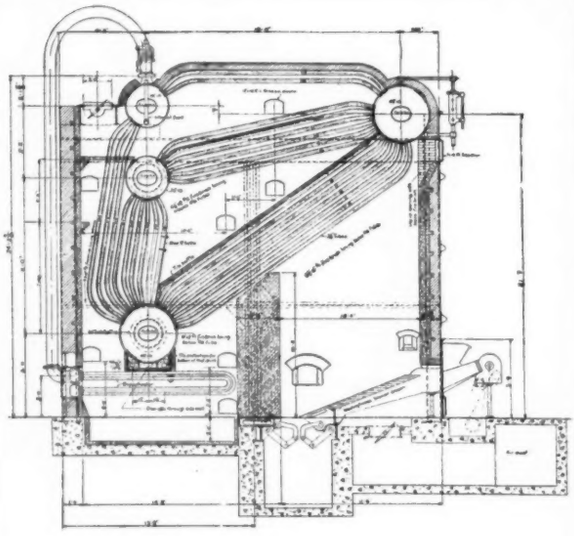
Erie City Iron Works

Erie, Pa., U. S. A.

"Save Money with Pulverized Coal"

The use of pulverized coal will make you independent of coal conditions and prices. The cheaper grades of coal can be made to supply you all the power you need.

Erie City Pulverized Coal Equipment furnishes the most practical and economical means to this end. One type of machine is used for all kinds of bituminous coal. Adapted to any method of drive. No pulverized coal is kept in storage. No dust. Ask for Bulletin.



The LASKER-ADAMS
Water Tube Boiler

The Lasker-Adams Patented Water Tube Boilers are built for pressures up to 350 lbs. and in capacities from 200 H.P. up.

Superheater may be located as shown or in the triangular space between the tubes above the furnace, and for superheats of 100 deg. F. or less can be built into and made part of the boiler itself.

This type of boiler lends itself to baffling in any desired form depending upon the requirements of the customer, type of fuel burned and other local conditions.

The illustration shows a complete counterflow, three pass installation.

This design of boiler while not departing in any particular from proven methods of construction, has by proper arrangement of parts shown that higher efficiencies can be obtained.

The features of the Lasker-Adams patented water tube boiler can best be stated in a few concise paragraphs:

Unimpeded Circulation
Gas Counterflow to Water Circulation
Means for drying steam
Built in economizer section
Ease of baffling, maintenance and replacement
Expansion strains automaticaly released
Placing as much of this surface in the path of gas moving downward as possible.

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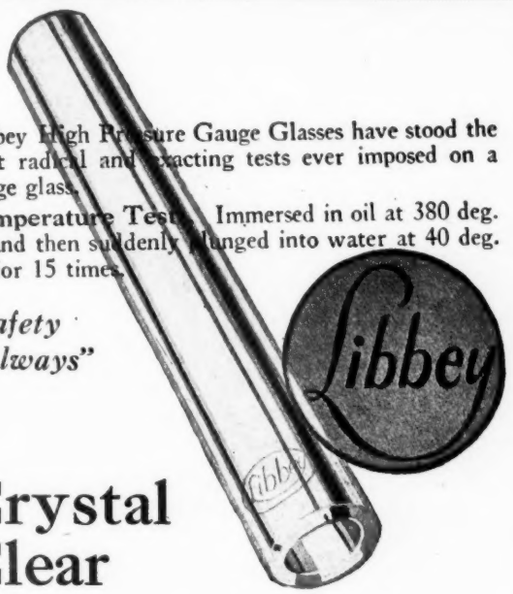

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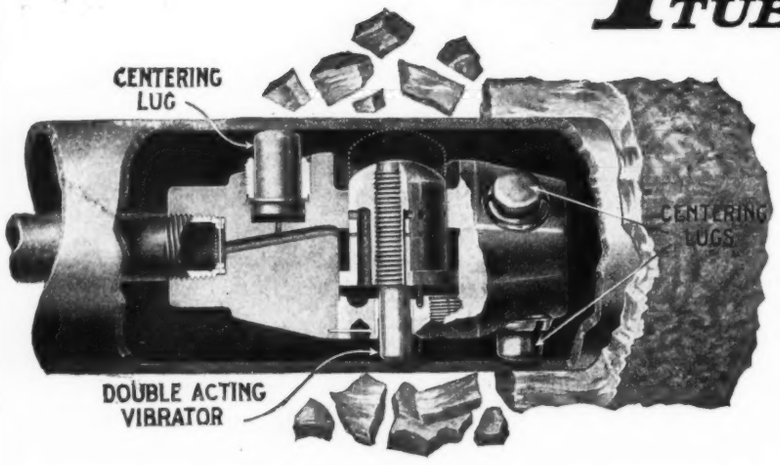

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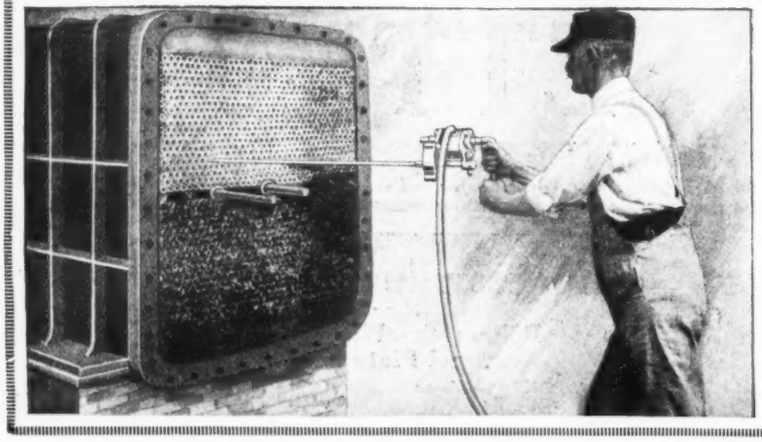

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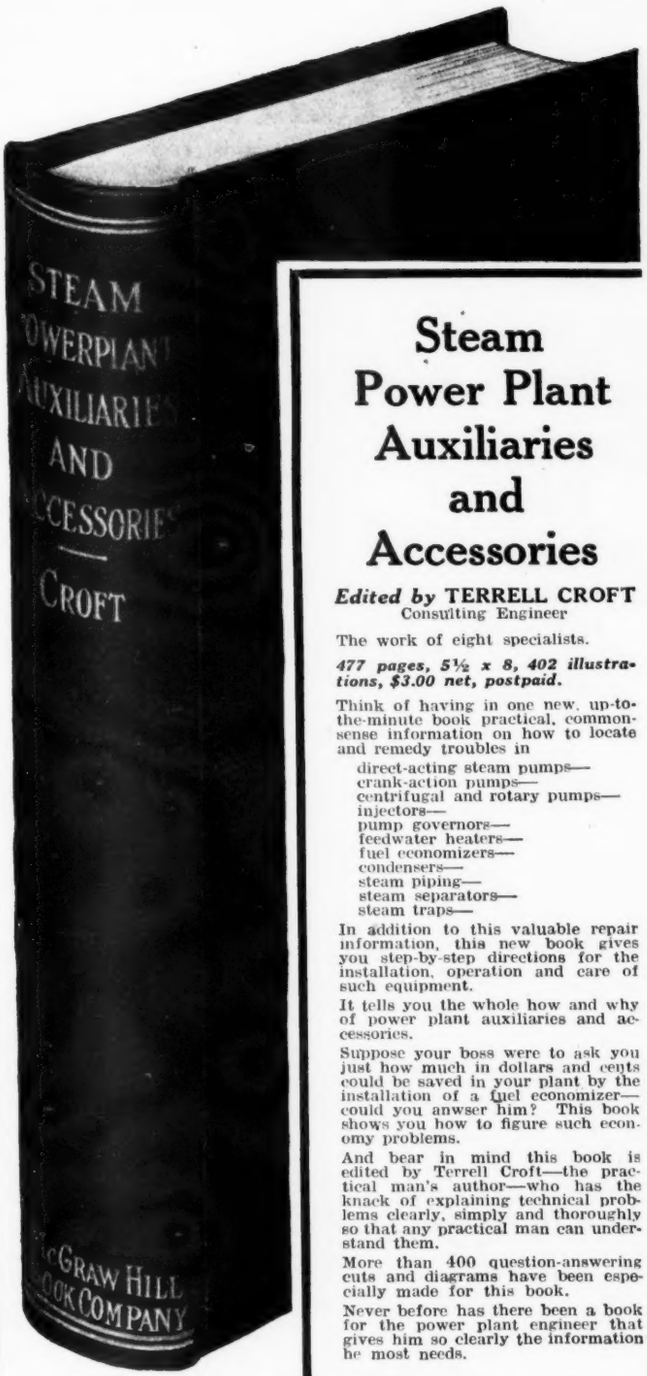

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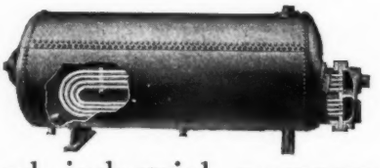

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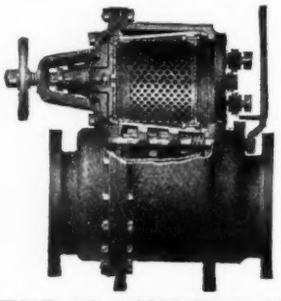

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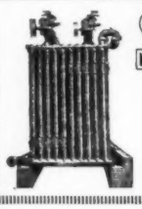

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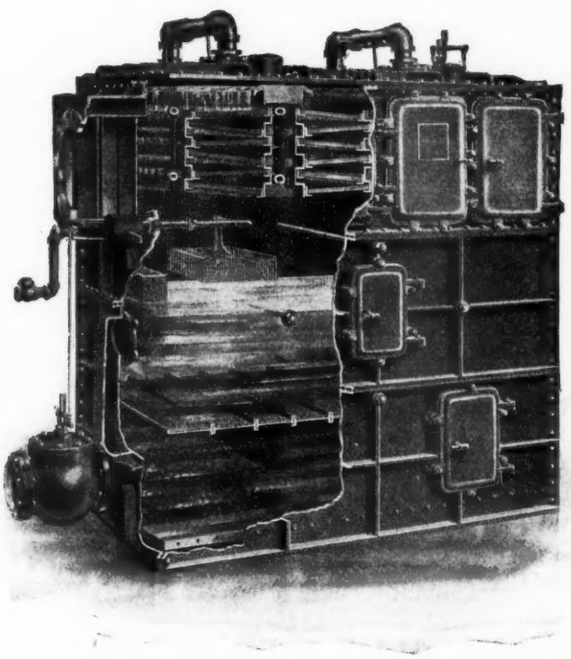

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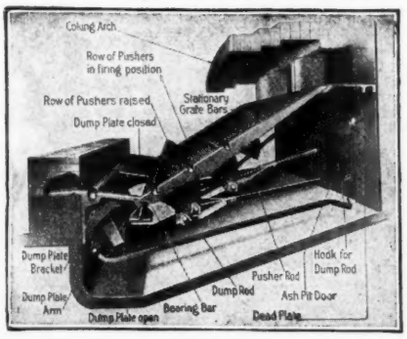

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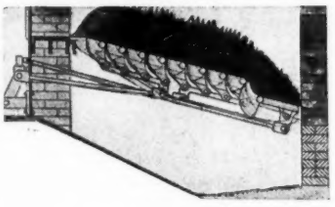

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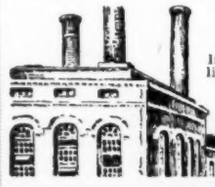

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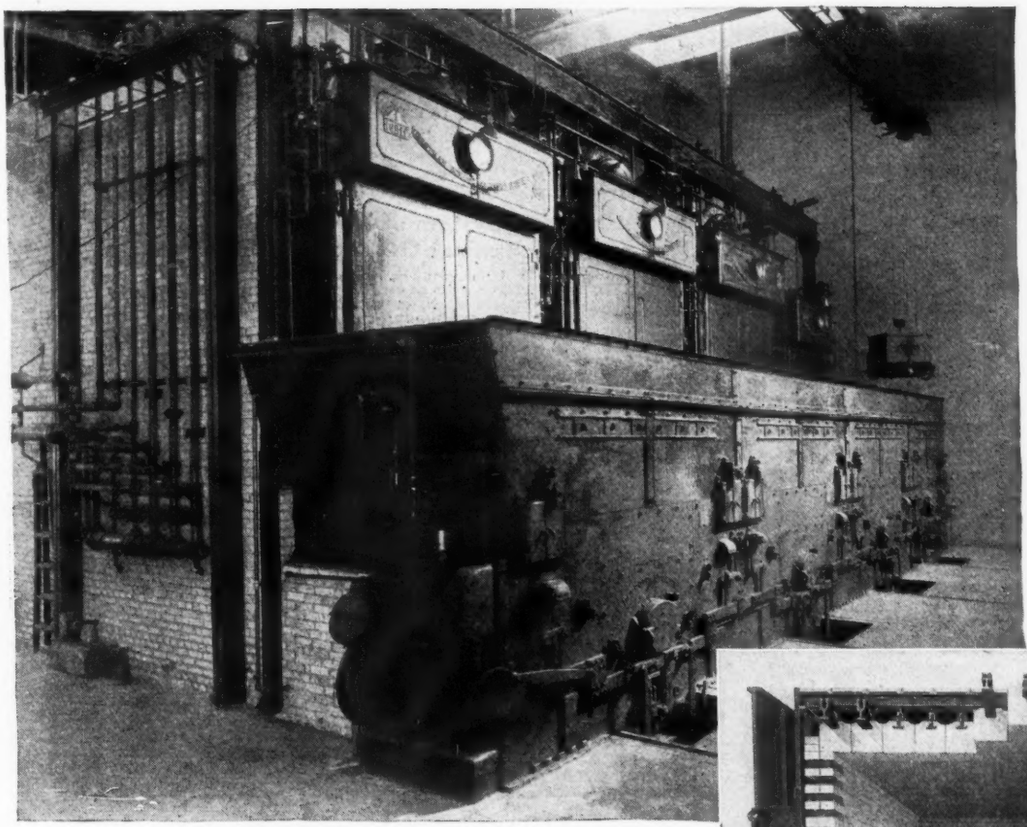

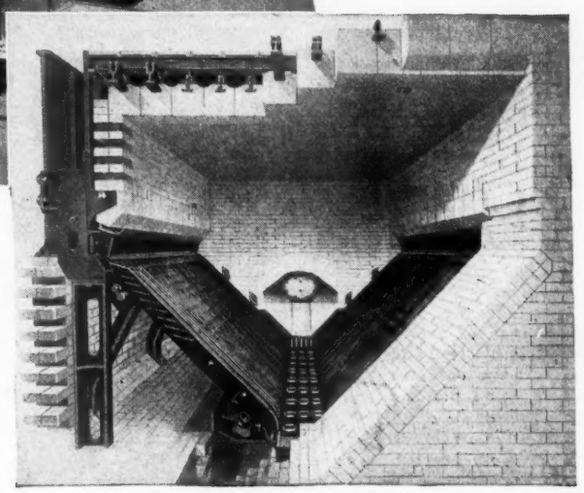

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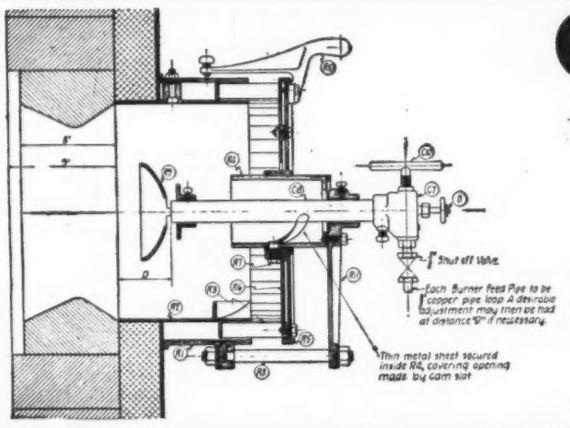
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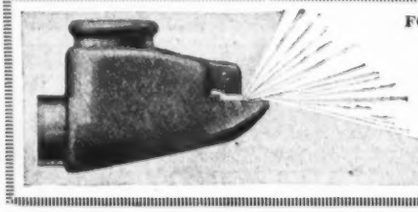

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W. E. ELLIS COMPANY

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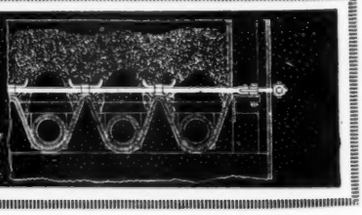

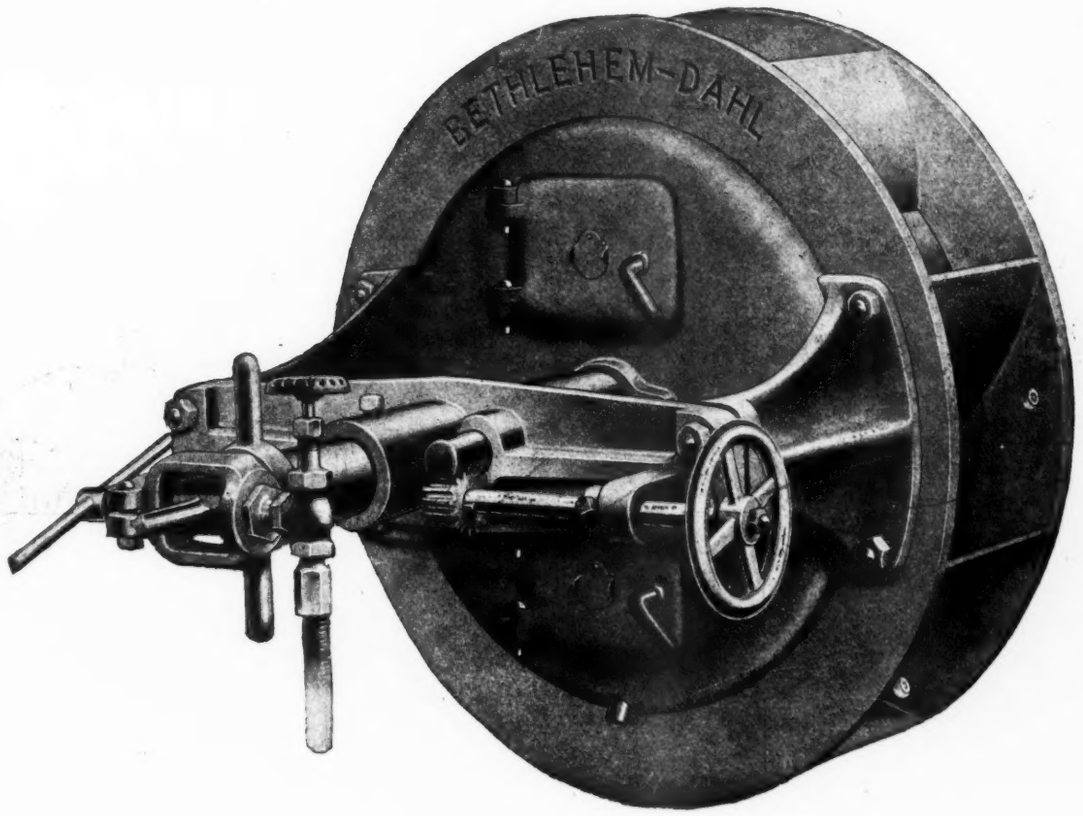

More steam

—*per pound of oil*

THE statement that steam can be generated with fuel oil at far less expense than with coal is true beyond all possibility of argument.

But just how much you can save by the adoption of oil burning depends on several factors. One of the most important of these is the kind of oil burning system you use.

The Bethlehem (Dahl) System does not divert any of the steam from useful work to the non-productive purpose of atomizing the oil. That is because the Bethlehem (Dahl) System atomizes the oil mechanically, without the use of steam or compressed air.

Another economy feature is positive air control, enabling the operator to admit the exact quantity of air required.

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These features help the Bethlehem (Dahl) System to give more steam per pound of oil.

To the power plant owner who installs the Bethlehem (Dahl) System these features mean the saving of many dollars each year.

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McClave products include grates and stokers for every service and for all solid fuels; McClave Argand Blowers; and McClave Boiler Fronts.

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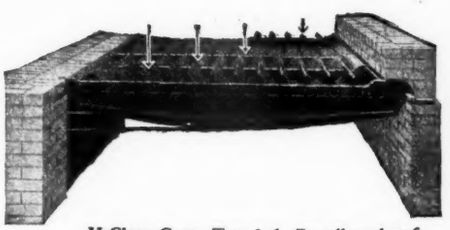
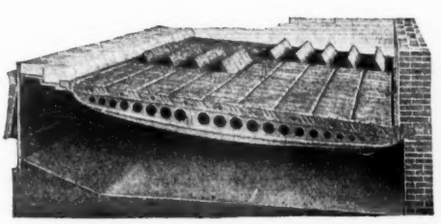


McClave Grate, Type 2-A. For all grades of bituminous coal, lignite, bagasse, etc.



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to burn the poorest grades of bituminous or anthracite coals can be cheaply secured with

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Operate at pressures up to 8 inches of water. Unexcelled in operating efficiency. Readily installed in any boiler setting. Applicable to all types of stokers or hand firing. Consult with our engineers regarding your requirements.

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Electric drive. Also in turbine drives. Capacities from 125 to 40,000 C.F.M. Efficiency as high as 80 per cent.

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gives dependable valve-control of your fire. Easily maintains uniform steam pressure. Interchangeable parts.

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Built in sizes to handle from 1600 to 275,000 cu.ft. per minute at pressure up to 7 inches of water.

Learn why they are more efficient. Write for Bulletin No. 152.

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BEACON, N.Y.

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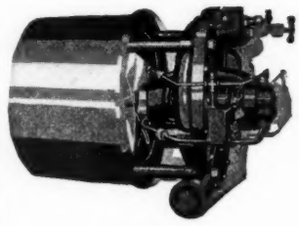

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The Original - The Standard 1905 since 1905
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More Capacity - Better Efficiency with any fuel

L. J. Wing Mfg. Co.
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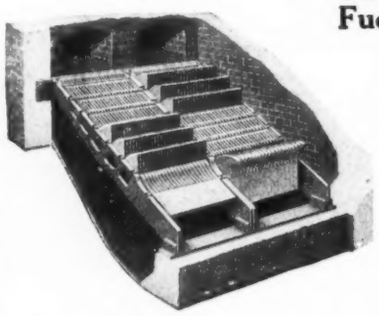
To Economize Fuel—



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Much heavier in design than other types. Ample provision for expansion and contraction. Abundant air space. Easily operated by outside levers. Write for Bulletin.

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For small anthracites, screenings, lignite

Eliminates sifting.
Insures increased boiler output.
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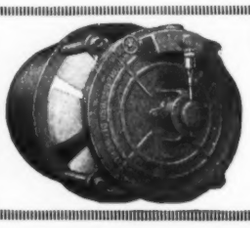

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Turbines-Damper Regulators
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COSTS NO MORE — Eliminate warping and buckling of flues, breeching and sheet metal work, subject to expansion and contraction. — ERECTED ANYWHERE
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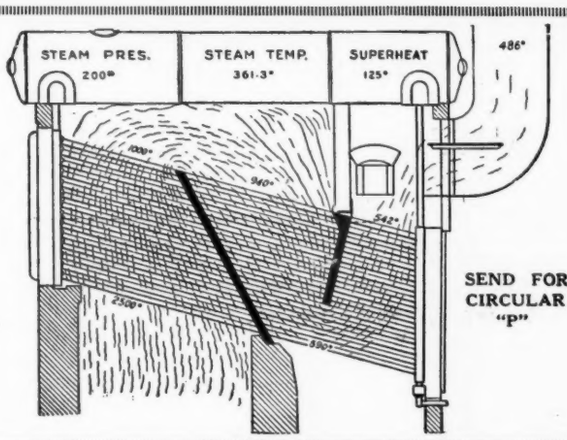

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A method of continuous furnace maintenance; fill holes with Maphite Cement—apply heat-resisting Maphite Paint. Ask for descriptive folder.

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MADE FROM CELITE
Insulating Brick and Powder

Saves 60 per cent to 70 per cent of the heat lost through boiler walls and settings. Write for Bulletin K-6A.

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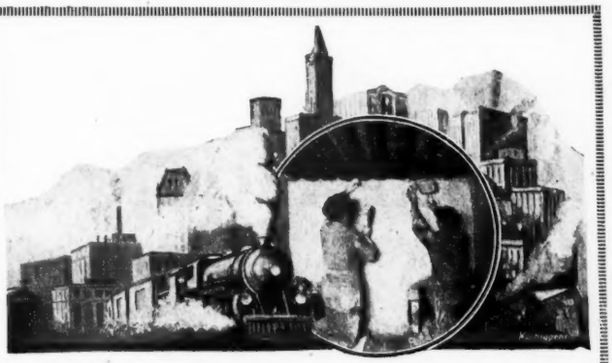

Furnace building has kept pace—

WITH greater commercial development came the call for higher boiler ratings. With higher capacities came jointless Plibrico Furnace Lining.

Plibrico will withstand the over-ratings of the present day. It is a plastic lining that is pounded into place with a mallet and that when baked, forms a seamless, rock-like wall that resists temperatures to 3100 deg. F., that is air and gas tight and that far outlasts fire brick.

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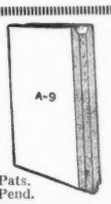

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form a practically hollow wall which is kept cool by the circulation of Pre-Heated Air thru same. Lasts longer under higher temperature and makes frequent relining unnecessary. Write for details.

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Pneumatic conveyors for handling granular and pulverized materials of all kinds

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Electric Motor, Clam Shell, Orange Peel and Drag Scraper Buckets for all excavating, digging and re-handling purposes.
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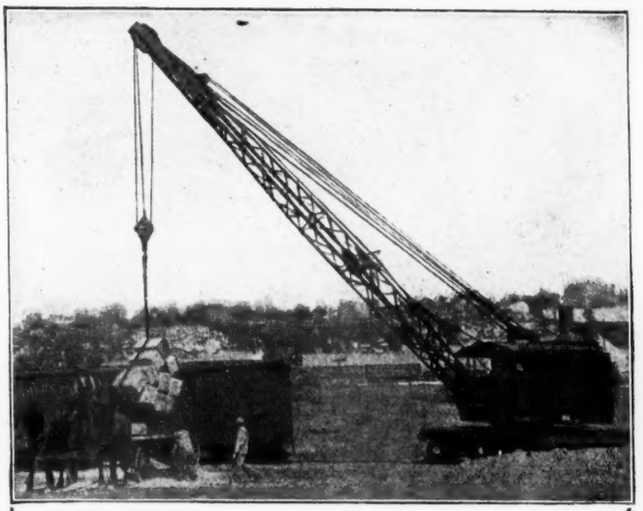

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Machinery deck is a solid one-piece casting; holds all working parts in alignment.

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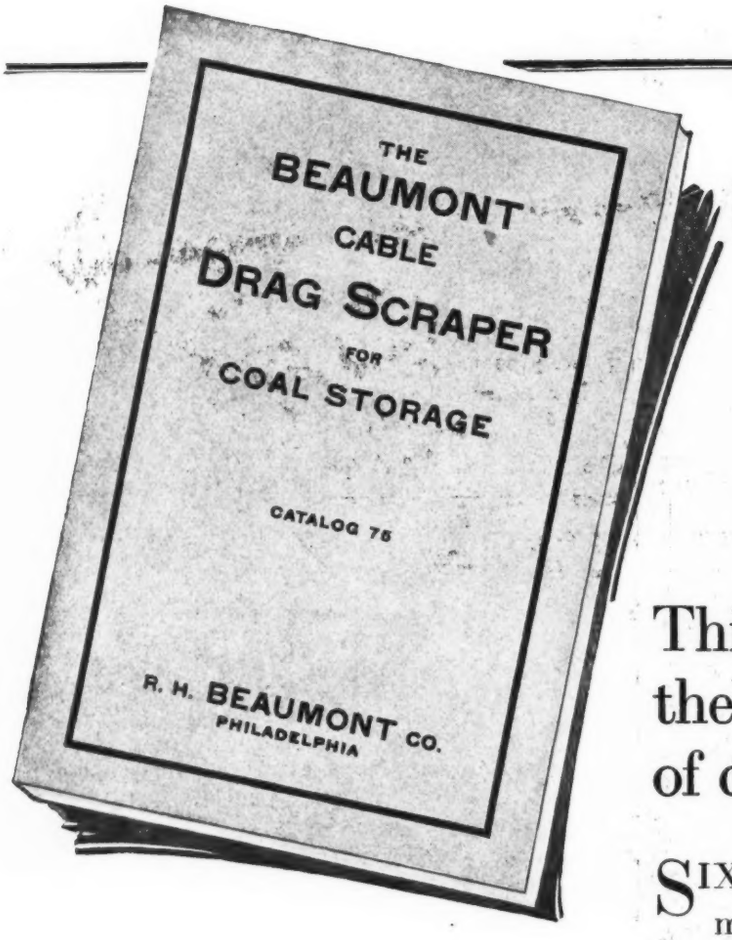

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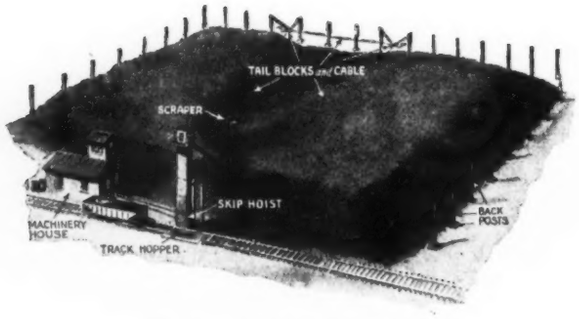

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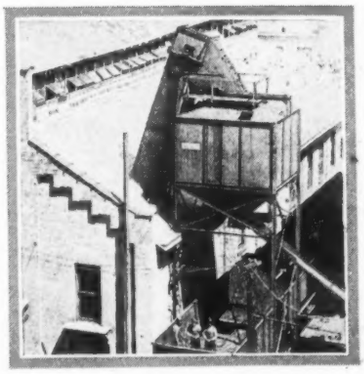

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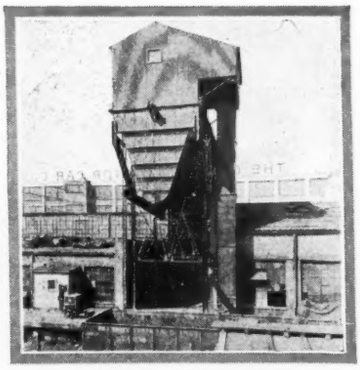

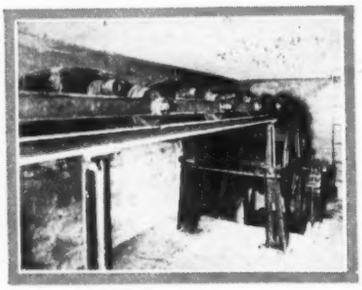

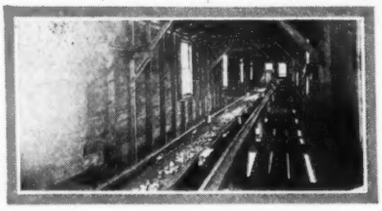

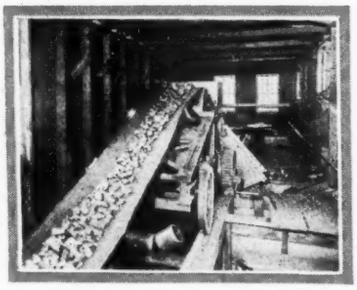

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Blaw-Knox Bucket mounted on a BUCYRUS 14-B SHOVEL

Know a Blaw Bucket by its solid cast head

A BLAW-KNOX BUCKET

Reduce Your Need For Common Yard Labor

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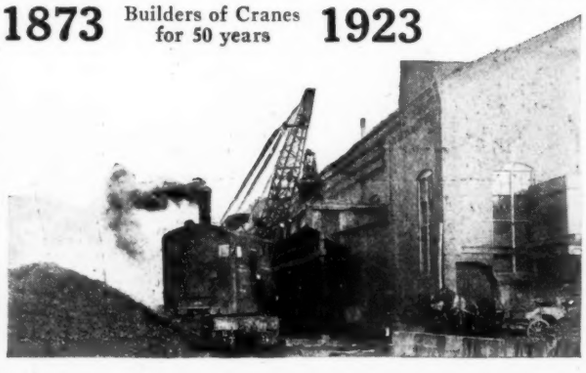

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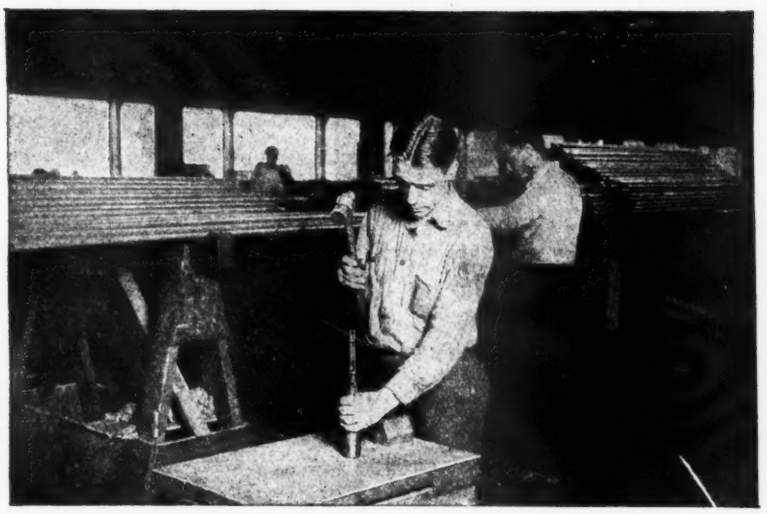

THE PIN TEST

"Each test tube will be subjected to an expanding test. This will be carried out by driving a pin with a taper of 1½ inches to the foot into the tube until the internal diameter has been increased 16⅔%."

Navy Specifications
44-T-7-C

The pin test is one of many checks on the temper of condenser tubes. Microphotographs, hammer, compression and water tests and analysis all play their part in guaranteeing the temper of the tube, and scrupulous observance of these tests insure good tube service to the user.

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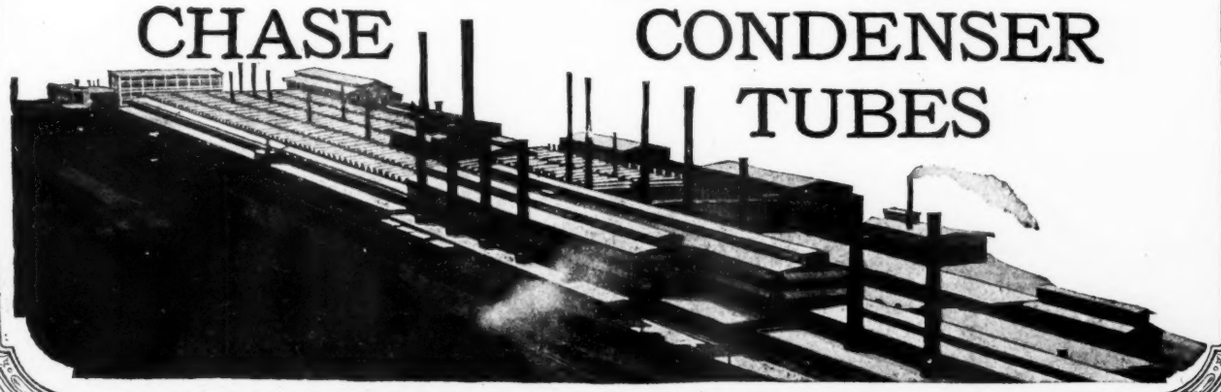

Type CCC Coppus Centrifugal Turbo Boiler Feed Pump, single stage. Insure smooth, steady feeding for moderate boiler pressure.

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Turbo Boiler Feed Pumps

Designed for the small and medium size power plant, give the same high efficiency, continuity of service and low repair cost experienced with larger centrifugal pumps in the central station. Smooth feed water flow eliminates shock, vibration and trouble. Let COPPUS PUMPS realize this desirable condition for you.

Ask for Bulletin on the two types shown here

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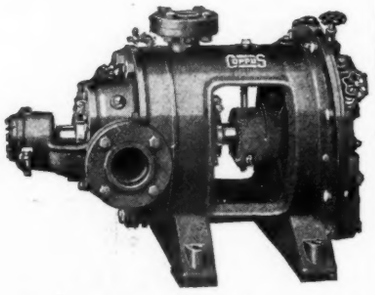

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Pumps -- Governors -- Compressors

If Gardner pumps and compressors had not made good you would not find them "on the job" in the finest installations all over this country and abroad.

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Durable, Efficient, Dependable

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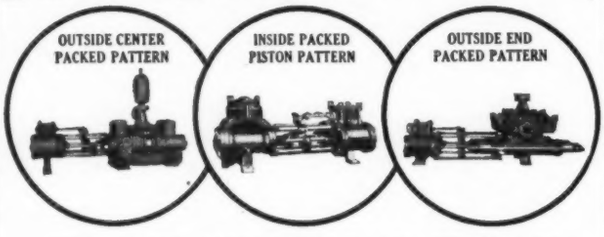
DURABLE DUPLEX STEAM PUMPS



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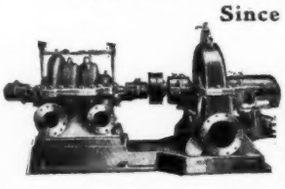
Since 1889



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Centrifugal pumps, reciprocating pumps and steam turbines.
Complete turbo-pump, generator and fan units.

PUMPS and TURBINES FOR EVERY SERVICE

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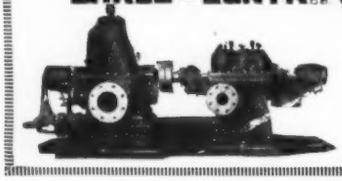

For all purposes where centrifugal pumps of the better class are adapted.

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CENTRIFUGAL PUMPS
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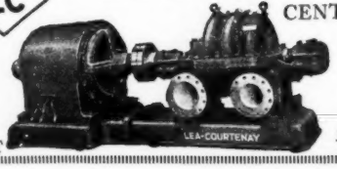

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Manistee Iron Works Co., Manistee, Michigan

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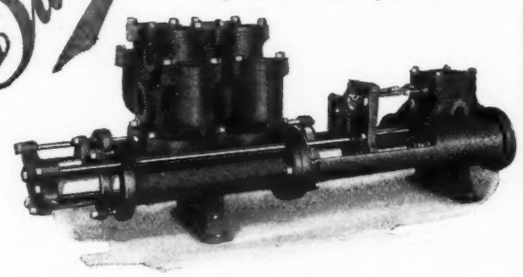
Fig. 505

The built-in quality of every Taber Pump means complete satisfaction in service. We are Pump Specialists.

Taber Pump Co.
Buffalo, N. Y.
Builders of Centrifugal and Rotary Pumps.

"Buffalo" Duplex Valve Pot Pumps

up to 300 lbs. pressure



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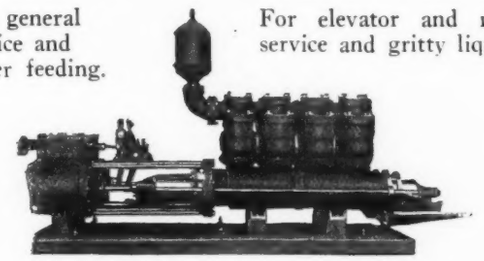
For elevator and mine service and gritty liquids.



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Established 1886

No other part of your power plant equipment has a more important function to perform. Upon your injector depends the safety and continuous operation of your plant.

Should the feed pumps or a part of its piping fail—the injector must be ready to take up the burden of feeding the boilers or a shutdown becomes inevitable.

You cannot afford to experiment here. Insist upon a genuine PENBERTHY and safeguard the future for continuous operation.

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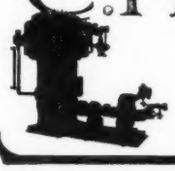
C. H. WHEELER CONDENSING EQUIPMENT



Surface Condensers, Low Level Jet Condensers, Barometric Condensers, with all auxiliaries, including the Radojet Ejector Air Pump

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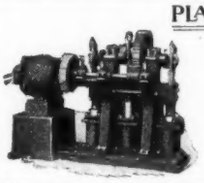

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McGOWAN DUPLEX STEAM AND POWER DRIVEN PUMPS

For every Industrial Activity

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SCOVILL CONDENSER TUBES LAST LONGER

Use Cup Drawn Admiralty for salt water.
Use SCOVILL Special Muntz for fresh water.

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Built for every purpose in all sizes for any drive. They are of latest split-casing, high efficiency, bronze fitted construction. Furnished in horizontal and vertical shaft and multi-rotor types.

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And that means that you will get a better spray with less pressure.

Badger Non-Clog Nozzles operate perfectly on as little as 3½ lbs. pressure. Four of them are equal in cooling effect to five of the old-type nozzles. The illustration shows that there are no restrictions to the flow. Easy to install.

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"Wyoming" Automatic Eliminators and Separators

For Draining Main Steam Lines — Saturated or Superheated.

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For Draining Heating Systems, Steam Jacketed Kettles, Small Separators, and all Ordinary Trap purposes under any pressure.

Built of cast iron or cast steel for all pressures

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100% PERFORMANCE and SATISFACTION

"SprArite" Cooling Systems stand absolutely alone in the field for performance and satisfaction. It is the most simple and reliable means of cooling water and is daily commended by satisfied users.

We design and furnish complete Spray Cooling Systems for Power Plants and guarantee successful operation.

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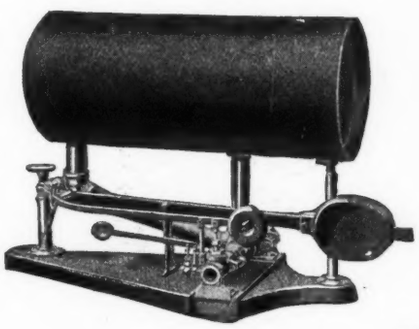
Does Condensation Work *For or Against You?*



Does it collect in your steam lines, separators, process equipment or heating system, retarding steam circulation and insulating against heat? Or does it drain freely and constantly and form a cheap and convenient source of hot boiler feed?

A Morehead Back-to-Boiler System will do away with the condensation nuisance by draining it as it forms. It will keep your equipment piping hot and increase its capacity. It will deliver condensation to the boiler at its original high temperature without pumps or injectors. It will increase efficiency or decrease fuel consumption.

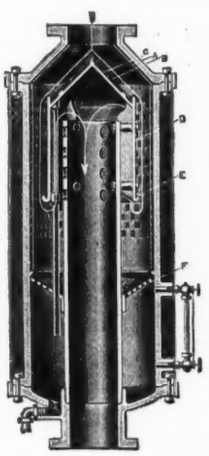
Let us do for you what we are doing for others.

MOREHEAD MFG. COMPANY
Dept. P. M. Detroit, Mich.

(99)

Morehead
"BACK-TO-BOILER-SYSTEM"
POSITIVELY DRAINS ALL TYPES OF STEAM APPARATUS. DELIVERS CONDENSATION AND FEED WATER TO BOILERS UNDER ALL CONDITIONS AT MAXIMUM TEMPERATURE

For Dry Steam



You are safe in following the lead of thousands of experienced engineers by installing

SWEET'S Direct Separators

They insure 99.8% dry steam at all loads which will result in material savings in fuel, oil and repairs.

The high efficiency of these separators is responsible for the fact that over 50% of our sales are repeat orders.

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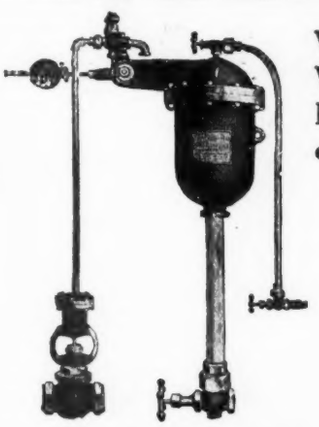

Why Put Up With Out-of-Date Hand Regulation of Boiler Feed?

You can never hope to attain maximum economy and efficiency with it. Between high water and low water your profits will continue dribbling away.

VIGILANT
Feed Water Regulators

Provide automatic mechanical regulation that can be depended upon to keep the water level at middle gauge. They hold the water level at a fixed point, under all operating conditions and at all boiler loads.

They require no attention. Their operation depends upon gravity and NOT upon expansion tubes, floats or diaphragms. The money saved pays the cost of a good regulator many times over.

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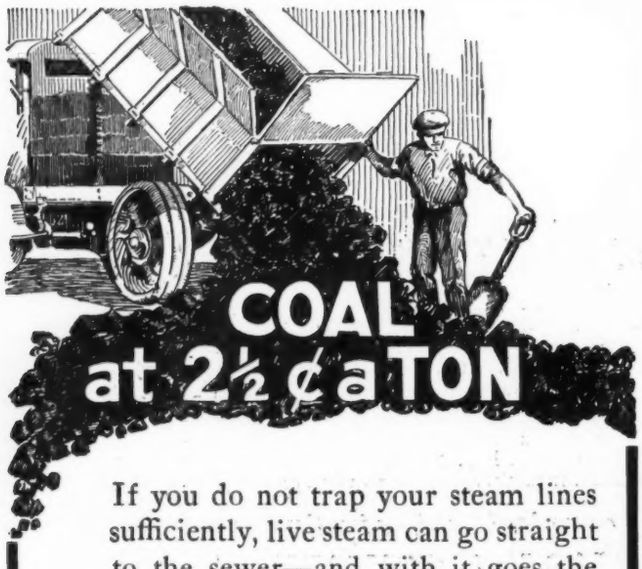
Also Manufacturers of the Fulton Pump Governor

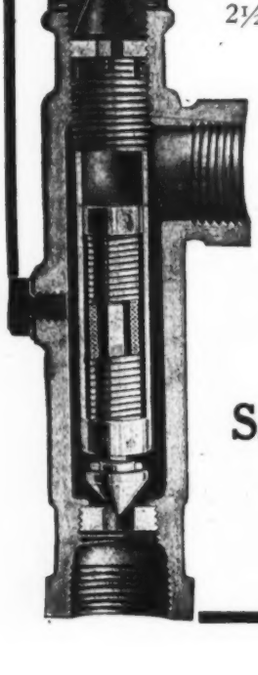


If you do not trap your steam lines sufficiently, live steam can go straight to the sewer—and with it goes the cost of the coal burned to produce the steam. Just one untrapped ¾ in. steam pipe would waste more than a ton of coal every 52 hours.

You can positively prevent that waste at a cost of $9.45 list, for a

STEAM TRAP SARCO

Figuring on the probable life of a Sarco Trap, it would cost you about 2½ cents during a period of 52 hours. And as it saves a ton of coal in that time, the Sarco is, in reality, *buying* the coal it saves at a cost of 2½c. a ton.



The Steam Trap Sarco does the same work as traps that cost three times as much. And it possesses many worthwhile advantages.

Let us send you our interesting Booklet A-40 and full particulars about our free trial offer.

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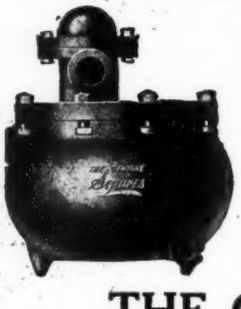
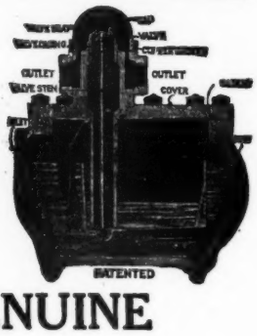
STEAM TRAP





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Equipped to give simple, satisfactory and low-cost protection against steam waste in high pressure power plants and low pressure heating plants wherever a strong and durable steam trap is required.

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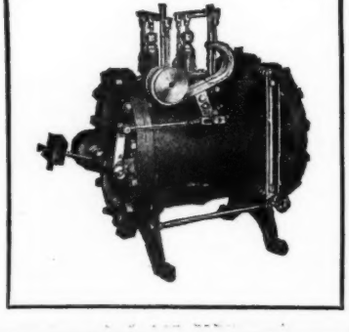
Reduce Boiler Stresses
SAVE COAL

Because they return the condensate under pressure at a temperature of 300 deg. F. or more, right into the boilers. Simple, strong and positive in action. Guaranteed for working pressures up to 225 pounds.



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STEAM TRAPS

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"VERTICAL"

{Equal results with upward or downward flow of Steam.}

RESULTS GUARANTEED.

Circulars and prices on application.

Detroit, Mich., Aug. 27/95.

Austin Separator Co.,

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We are also using one of your 4" vertical separators in live steam pipe, previous to its connection were troubled with moisture, which is entirely eliminated and are delivering dry steam to engine. We bespeak for your separators the success which their merits demand.

Very respectfully,

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{Can be connected either right or left hand.}

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1895-1923

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Correspondence regarding your requirements is invited

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Steam and Oil Separators
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HOW much better to look for that name—

SONDERGLASS—

"The Unbreakable Gauge Glass"

on the package *when* you *buy* it, than to look in vain for the clear unbreakable *qualities* of Sonderglass afterward. Because it stays clear longest, Sonderglass saves you money.

Order a trial dozen from your dealer or direct.

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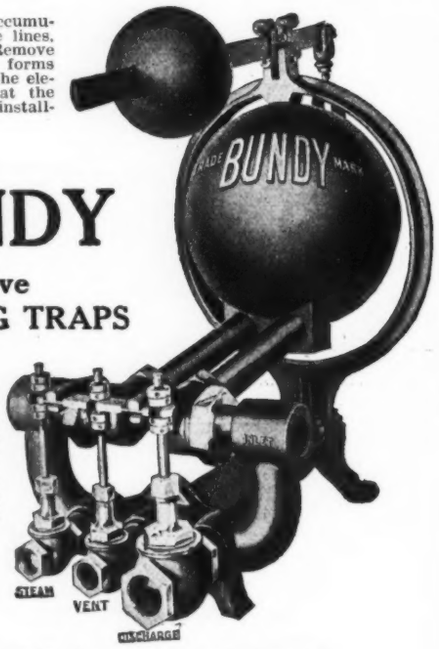
Don't let it accumulate in your pipe lines, receivers, etc. Remove it as fast as it forms and pump it to the elevation required at the lowest cost, by installing

The New

BUNDY

Three Valve PUMPING TRAPS



Will handle condensate under low pressure or vacuum. Very strongly constructed. Accurately machined. Upkeep costs are very low.

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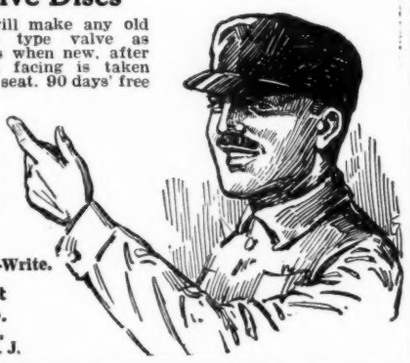
Valve Discs

They will make any old Jenkins type valve as tight as when new, after a light facing is taken off the seat. 90 days' free trial. Goetze Valve Discs have plenty of "spring" to allow for unequal pressure in seating. Naturally they will greatly outlast rubber composition discs.



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Steam Traps
Pressure Regulators
Damper Regulators

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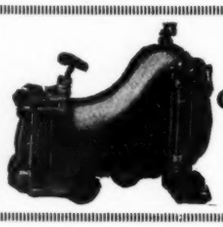

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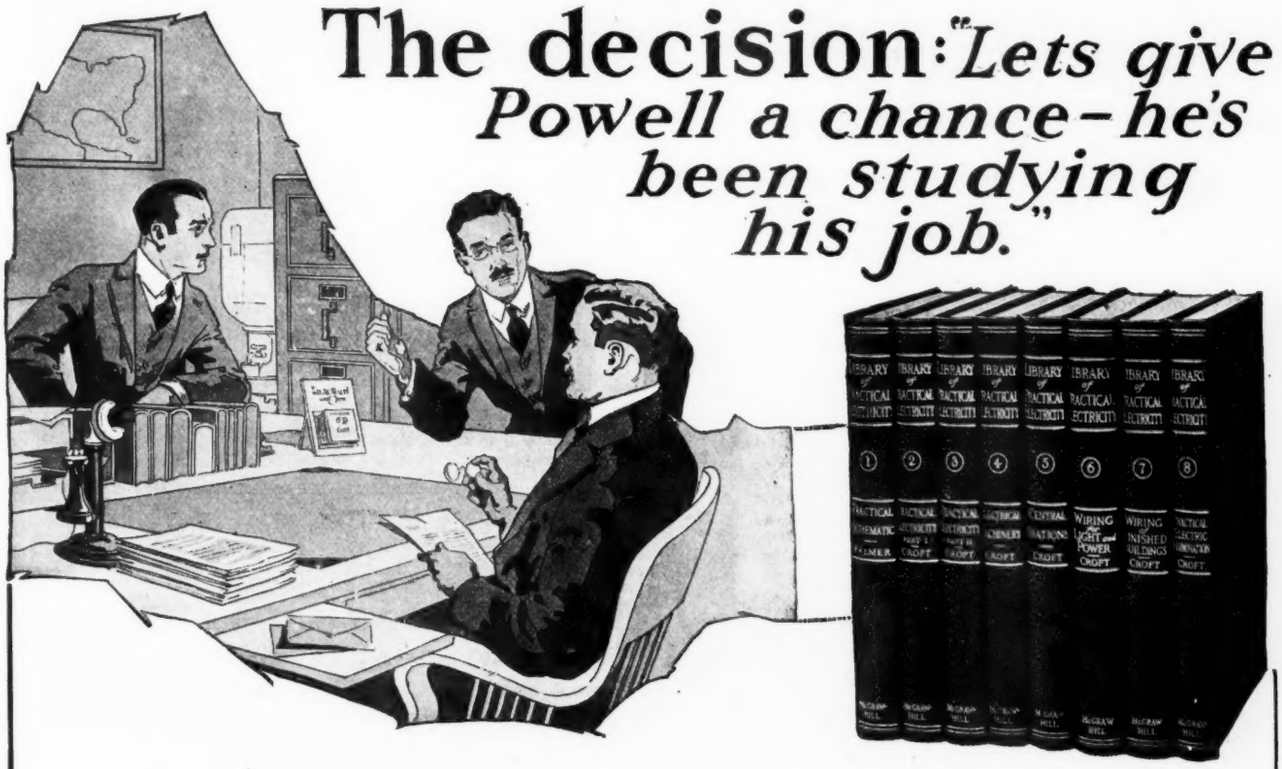
mean
CONTINUOUS OPERATION
without Steam Leakage
Write for information

Watson & McDaniel Co.
150 N. 7th St., Philadelphia, Pa.

The decision: "Lets give Powell a chance—he's been studying his job."



SOMEONE is wanted for a better job around the plant—someone with an all-round knowledge of electricity—someone who has shown initiative enough and grit enough to use his spare hours in preparing himself for a bigger job.

Powell gets the chance because he has stepped out of the narrow limits of his own work and prepared himself for the job ahead.

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OPPORTUNITIES in the world of electricity have always been plentiful, but today there are more high-paying positions open than at any other time in the history of electricity. New uses for electricity are constantly being found, and the great industries of the country are finding it hard to secure enough competent men to put these new ideas into practice. This, more than ever, is the age of electricity. The man who trains himself properly in the best electrical practice and engineering is bound to win a big place for himself. Make your *start today* by sending for this great electrical library.

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3. If you have a room or a building to light can you select the lamps properly and choose the correct reflectors and locate the units at the right heights and in the proper positions?

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5. Do you really understand the principles of alternating currents and alternating current circuits—power factor, inductance, reactance, impedance, permittance and the like?

6. Are you familiar with the modern electron theory of electricity which now renders easily understood so many things about electricity that were obscure formerly?

7. If you have to wire an old building with concealed wiring, do you know just how to go about it? Do you know all the time-saving stunts in fishing wires, boring race-ways, and how to make the tools required?

8. Do you know the National Electrical Code Rules and the reason for their adoption?

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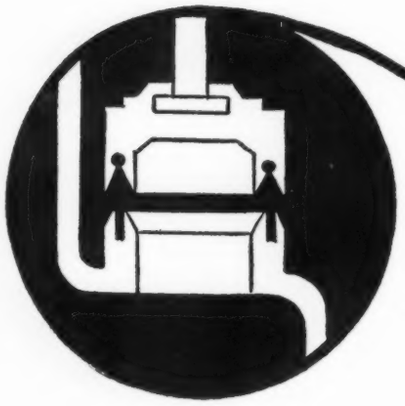
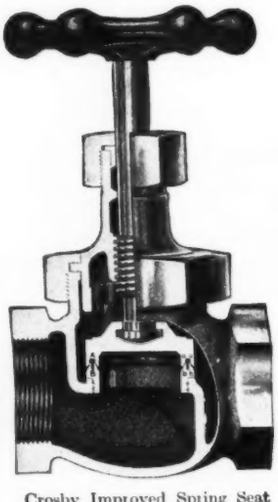
P. 6-26-23



This double security costs you no more

As the V-shaped grooved disc meets the annular V-shaped raised seat, two separate and distinct rings are formed. Since this *double* security against leakage may be had for the price of ordinary valves, why should you be without it? Ask your supply dealer for

CROSBY Spring-Seat VALVES



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FOR THE MOTOR OPERATION OF LARGE GATE AND GLOBE VALVES
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of steam from the header into a boiler in case of a tube rupture or other break. Equip all boilers with
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Made of either cast iron or open hearth cast steel with "Nickel Bronze" seats and discs that will not stick. Write.

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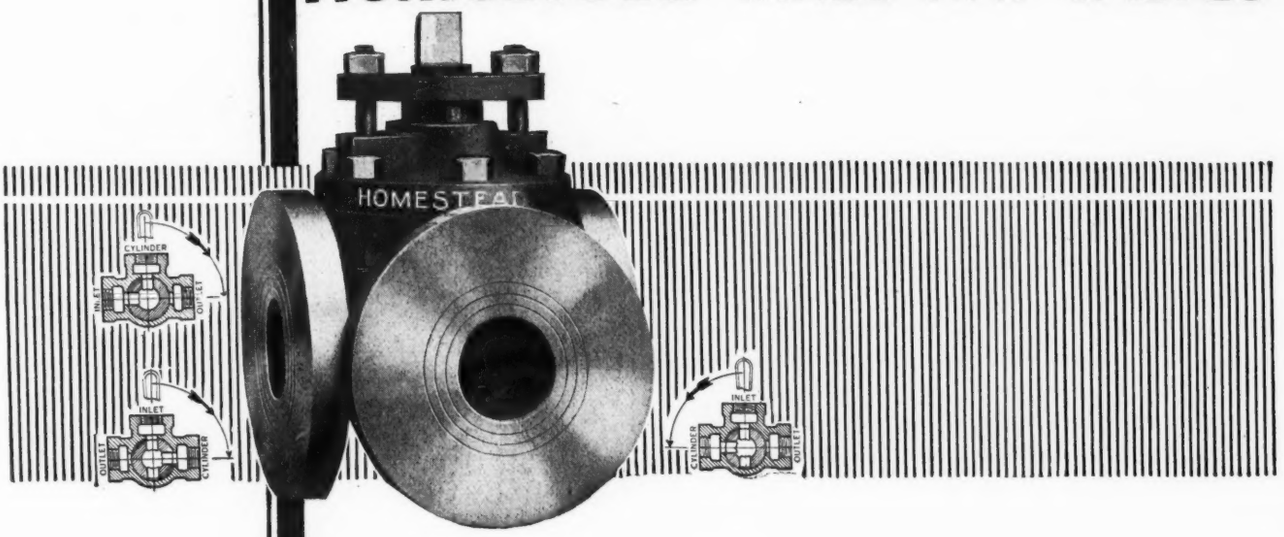

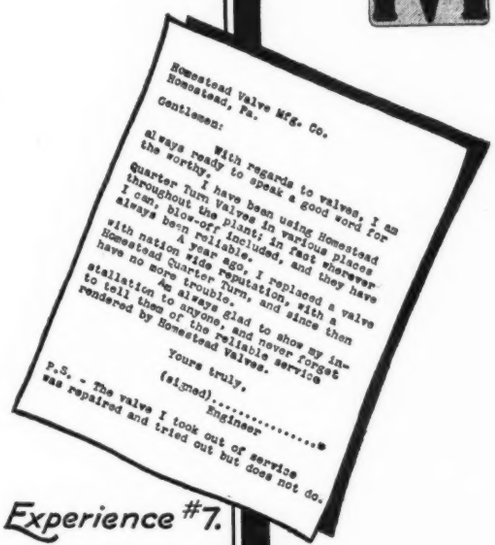

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Homestead, Pa.

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With regards to valves, I am always ready to speak a good word for the worthy. I have been using Homestead Quarter Turn Valves in various places throughout the plant in fact wherever I can, blow-off included, and they have always been reliable. A year ago, I replaced a valve with nation wide reputation, with a Homestead Quarter Turn, and since then have no more trouble. We always glad to show my installation to anyone, and never forget to tell them of the reliable service rendered by Homestead Valves.

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P.S. - The valve I took out of service was repaired and tried out but does not do.

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HOMESTEAD Three-Way-Valves have stood the test of exacting service for many years. Like other Homestead Valves, they are the product of extensive research into the needs of the trade, accurate design, and expert workmanship. They can be used under the most exacting conditions where a three-way-valve is necessary.

Read the letter on the left. By insisting on Homestead Valves on all of your equipment much of your valve trouble, necessitating costly shut downs, will be eliminated, as was the case with this user.

Send for the Homestead Catalog. It covers the entire field of our products, including the famous "Hovalco" Blow-Off Valve and Homestead Lubricated Valves. Send today.

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Shorter Time, Lower Costs to Install Piping

Crane service affords a single source for the supply of your piping equipment. All valves, fittings, pipe bends and steam specialties required for a plant of any size can be delivered at the same time.

As an additional means of saving time and expense, Crane standards of manufacture insure immediate and accurate fits in assembly. Specified dimensions in Crane equipment are exact. Complete piping systems in which all units fit smoothly into place, as they did in the trial assembly at the Crane factory, are being installed daily for every class of service.

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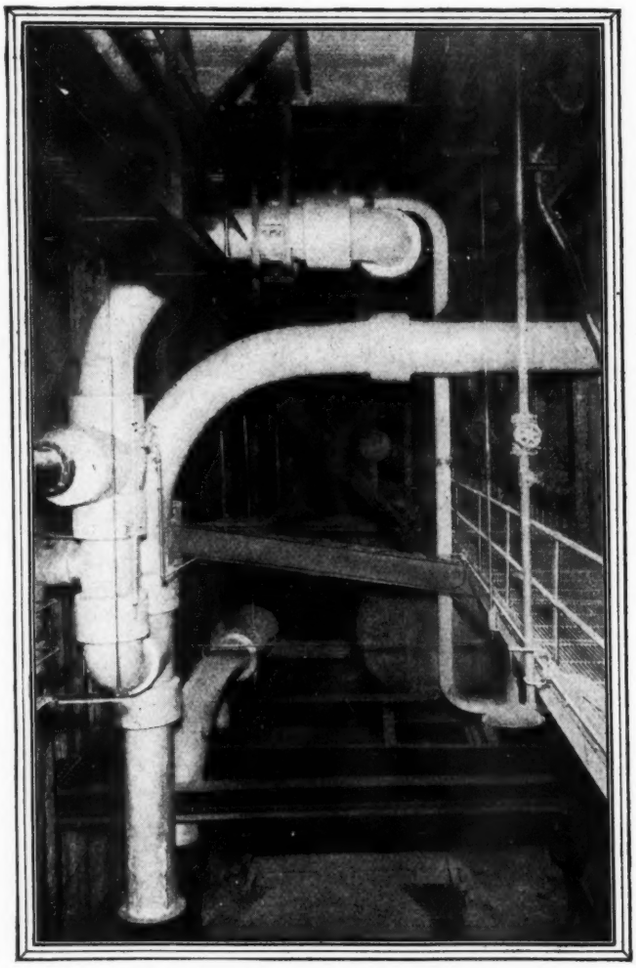

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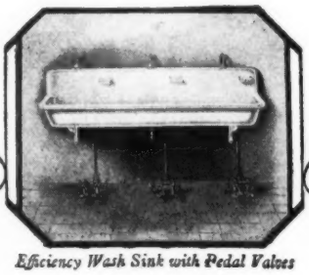
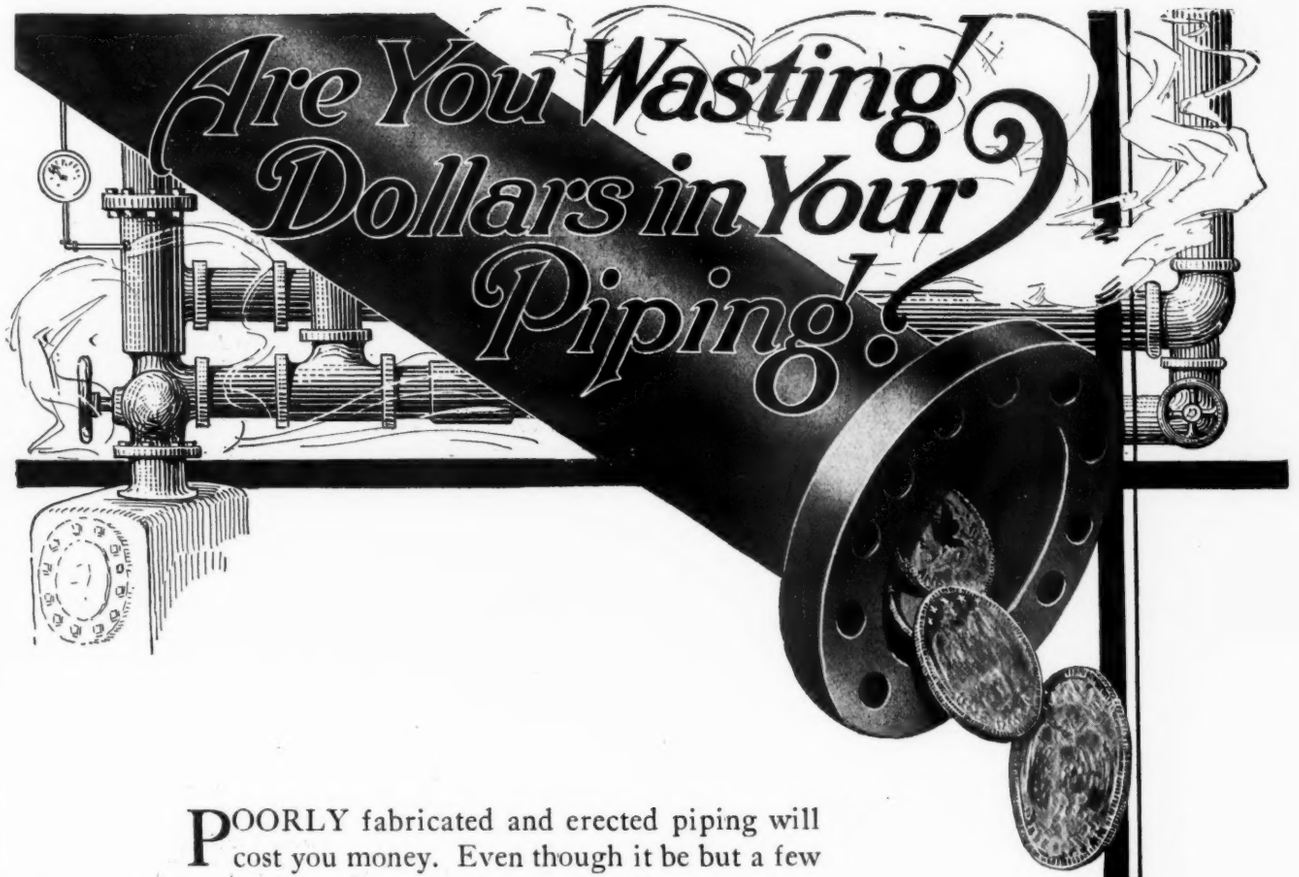


Efficiency Wash Sink with Pedal Valves



POORLY fabricated and erected piping will cost you money. Even though it be but a few cents a day—in a year's time it will amount into many dollars. Combined with the reduced life of the system caused by numerous repairs, the loss due to poor piping will more than pay for the best.

We have had years of experience in power plant piping and will be glad to work with your consulting engineer. NATIONAL installations have a reputation for endurance and efficiency that exceed, in many instances, original estimates. Let us render you this service.

Send for our catalog "Dimensions for Piping Equipment." It should be in the hands of everyone who has to do with power piping.

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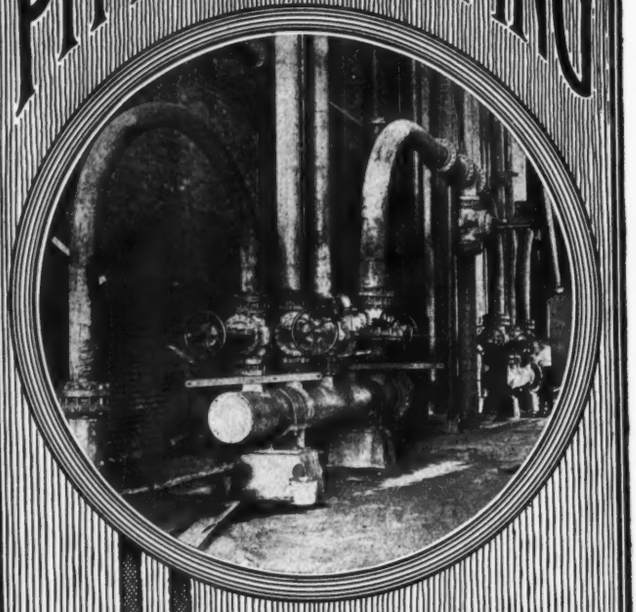
PITTSBURGH PIPING



FOR

POWER PLANTS

PIPING is as important as the power generator, but owing to its being comparatively inconspicuous, receives less consideration than its cost and importance warrant. Wise choice of material, proper design of the entire piping system, correct fabrication and erection, not only safeguards continuous operation but makes operation more economical.

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Wrought steel headers with welded-in nozzles for modern requirements of high pressures and temperatures, are used where lightness and strength are desired.

This company is prepared to contract for piping installations at any place in the United States and Canada and for any service including the highest pressure of superheated steam and hydraulic working pressure up to 5000 lbs.

Pittsburgh Piping & Equipment Co.

Manufacturers and Contractors

Specialists in Welded Wrought Steel Headers, Flanged Iron and Steel Fittings, Pipe Bends and Fabricated Piping for Power Plants

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WHEN YOU THINK OF **PIPING**, THINK OF

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A Powers for Every Heat Flow

Powers Specialties reflect credit on the man who specifies them for they insure satisfactory results—and there is a Powers Heat Regulator for practically every place where exact temperature is necessary.

Put your heat control problems up to us, without any obligation to you.

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They Have *Proved Satisfactory*

wherever they have been installed—and that is the principal reason for the wide distribution of

DART UNIONS

Probably it was the **Bronze to Bronze Seats** which prevent corrosion or maybe it was the leakless service which is found in Dart—at any rate they have made good in every respect.

Ask Your Dealer or Write Us Direct.

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Pipe Cutting and Threading Machines

Made for all pipe sizes to 16-inch
Hand, belt or motor drive

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WYCKOFF STEAM PIPE COVERING

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An ideal steam pipe covering, composed of two casings of Gulf Cypress, "The wood eternal", wire bound and coated with Montezuma Asphalt. Total thickness 3¼ in. Unaffected by soil conditions. An ideal non-conductor of heat. A continuous fuel saver. Write for catalog.

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Agents in principal cities
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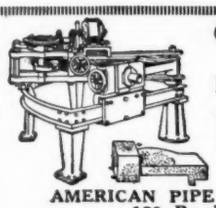
COLD PIPE BENDERS

Standard of the World

HAND AND MOTOR OPERATED



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What it costs to bend pipe our way. Per Bend:
1-in. pipe, 5 cents 4-in. pipe, 25 cents
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8-in. pipe, $1.00.

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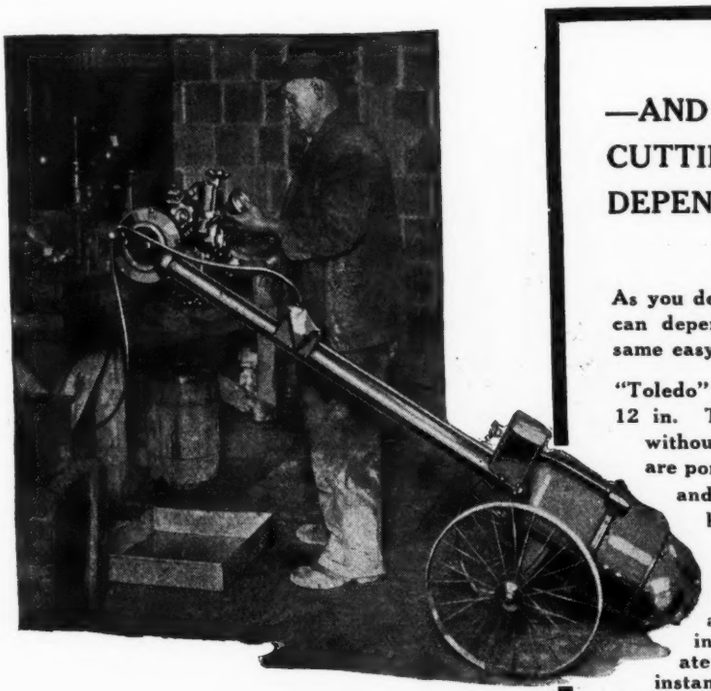
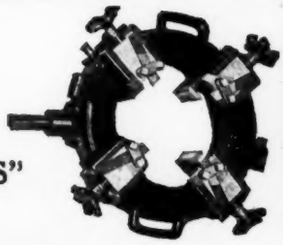


THIS ENGINEER DOES HIS PIPE CUTTING EASILY WITH HIS "TOLEDO" PIPE CUTTER AND "TOLEDO" POWER DRIVE.

—AND FOR PIPE CUTTING YOU CAN DEPEND ON "TOLEDOS"



As you depend on "Toledos" to thread your pipe, so you can depend on "Toledos" to cut off your pipe in the same easy, rapid, efficient manner.

"Toledo" Pipe Cutters are made in various sizes up to 12 in. They leave a straight, smooth, square end cut without burr, which needs no filing or reaming. They are portable, one man tools that may even be split apart and clamped around the pipe in the line, that is to be cut off.

"TOLEDO" TOOLS

are the ideal tools for cutting and threading pipe in all sizes up to 12 in. Portable and easy to operate with the ratchet handle, these same tools are instantly converted into swift power machines simply by connecting the "Toledo" Power Drive.

Only "Toledos" fill every requirement for perfect pipe tools.

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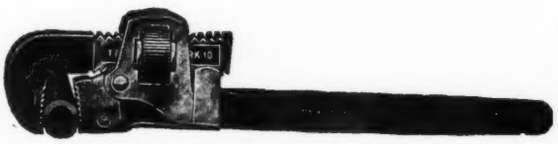
THE TOLEDO PIPE THREADING MACHINE CO. Toledo, Ohio

New York Office: 50 Church St.

Trimo Points



Trimo Pipe Wrench, Steel Handle, 8 Sizes Capacity 6 in. to 48 in.

The four good points that make Trimo Pipe Wrenches Superior—are the

Spiral Spring, always in place

Steel Frames, that will not break

Nut Guards, that protect the adjusting nut in close quarters

Inserted Jaw in handle, that can be replaced when worn, saving the handle.

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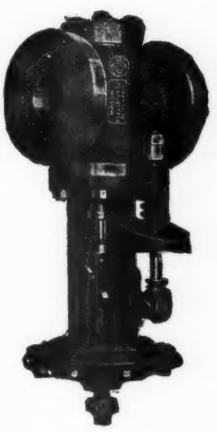
For Efficient Pump Control

Positive regulation of discharge pressures between 10 to 150 lb. is always certain with



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Made in sizes from ½ in. to 1½ in. with bronze bodies. Sizes 2 in. to 4 in. have iron body, bronze mounted.

A quality product that is backed by the Mason experience and reputation, extending over a period of 40 years.

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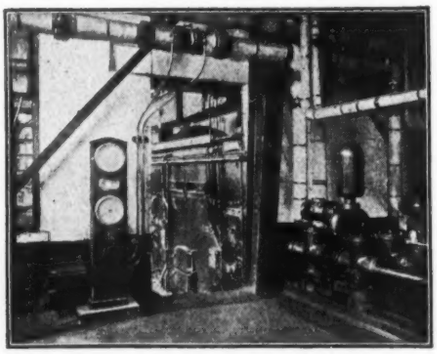
What is Going On in Your Boiler Plant



With fuel both scarce and costly, this is the question many an owner is asking his Chief Engineer. It is an important business which is carried on in the boiler plant and must be given serious attention. Accurate information of the evaporation of water for the amount of fuel burned each day is essential.

The VENTURI Meter

"Venturi"—Registered

is furnishing this information in thousands of boiler plants. Over twenty years of service has proved the Venturi to be supreme for boiler feed measurement. It has long since been accepted as the *standard meter* for the boiler room.

Bulletins 93 and 197 give details.

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YOU CAN SEE Thru the HAYS CHART

what is happening in the boiler room. Sources of waste are not merely pointed out; they are described in such a way that you can see at once what to do to eliminate them. Draft and CO_2 are both shown.

Hays Automatic CO_2 and Draft Recorders pay for themselves in a short time out of savings which they bring about.

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Combustion Efficiency Appliances
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TRIPLEX DRAFT GAUGE

Gives you accurate knowledge of furnace conditions at a glance. It indicates pressure in wind box, draft in furnace above the fire and in last pass.

It is designed and built for convenience of installation, maximum visibility and permanent accuracy. Each instrument must pass the Foxboro quality test.

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CORY-ROYER FLOW INDICATORS

Simple — Inexpensive — Dependable

Stationary and Portable Instruments for indicating the flow of steam, gas, air and liquids.

Write for complete information regarding our Portable Indicator Type T-200.

This Meter should be included in every plant equipment.

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CO_2

W-R Continuous CO_2 Recorders will accurately record the percentage of CO_2 in the boiler exit gases to guide the firemen and to show the engineer how efficiently the boilers are being fired. No liquid chemical. Order one for every boiler. Write.

Chadburn Engineering Co.
Fifth Ave., cor. Liberty St., Troy, N. Y.

Absolutely *"the best"* speed indicator for permanent attachment to a steam turbine or any other prime mover which operates between 900 and 8000 r.p.m., is our

FRAHM Vibrating-Reed TACHOMETER

This instrument is *"entirely different,"* and deserves fullest investigation. Used by U. S. Government and all standard turbine builders. *Write for Catalog* 853.

JAMES G. BIDDLE, 1211-13 Arch Street, Philadelphia

Check the temperature of your flue gases and save tons of coal

Record and measure your flue gas temperatures with

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Recording Pyrometers

and such information will enable you to minimize the loss of dollars in heat up the stack.

Bristol's Pyrometers will also warn you of any wrong tendencies—such as defective baffles, leaky settings, holes in fire-beds, etc. In short they make it possible to secure the utmost energy from every pound of coal burned.

Let us tell you more about what Bristol's Pyrometers can do for you. Write now for Catalog 1401-G.

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Tycos Pressure Recorders give accurate pressure readings on steam lines, boiler steam headers, superheaters, etc. *Tycos* Pressure recorders are built to suit your needs, recording from less than zero up to 1200 pounds pressure and over a period of from 24 hours to 7 days.

877

Catalog Part One, a reference book for power operator, will be sent upon request.

Tycos Temperature Instruments for
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Controlling

Taylor Instrument Companies
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There is a *Tycos* or *Taylor* Temperature Instrument for every purpose.

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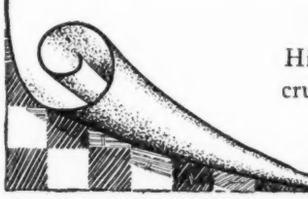

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PHILADELPHIA CHICAGO PITTSBURGH NEW YORK

Hyperbo-Electric Flow Meter

Eliminates Error by Eliminating the Source of Error

HYPERBO-ELECTRIC FLOW METER CO.
STEAM, GAS, WATER, OIL AND EFFICIENCY METERS
INSTANTANEOUS ELECTRICAL CO_2 RECORDERS
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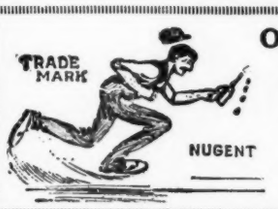

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Established 1897
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Hercules Seamless Copper Floats Last Indefinitely

Don't buy floats that wear out in a short time and have to be replaced. Hercules Floats, because of their remarkable endurance, eliminate constant renewal and repair expense.

Write for prices and details
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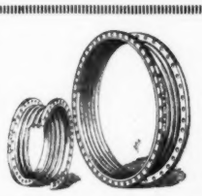

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Speeds at a glance. No timing
"Dead Beat" Accurate

Hand Tachograph

Draws graphic charts of speeds—30-24,000 R.P.M.

Circulars on request
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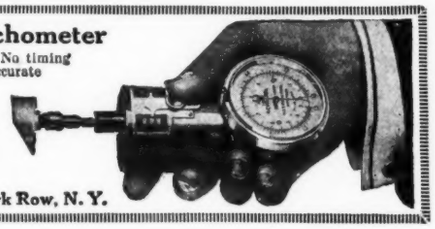

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Indicating and Recording Gauges, Gauge Testers, Indicating and Recording Thermometers, Tachometers, Temperature Controllers, Pop Safety and Water Relief Valves, Steam Traps, Engine Indicators, etc.
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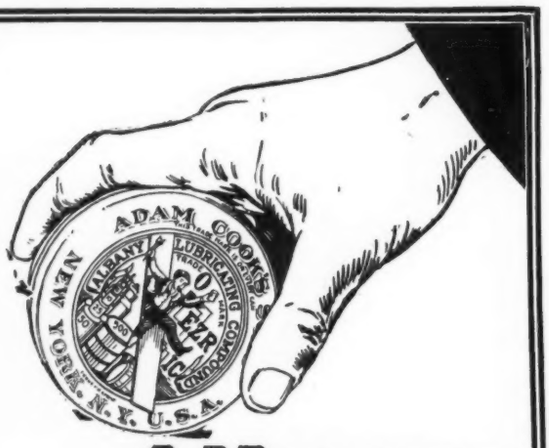
Brooklyn, N. Y.



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Write us for a free sample and give it a real test—or ask your dealer. He stocks it because he knows it's good.

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insures better results, greater efficiency and greater economy with less trouble and at lower cost. It's the one and only lubricant that will improve conditions at your plant and give perfect satisfaction.

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OHIO GREASE COMPANY
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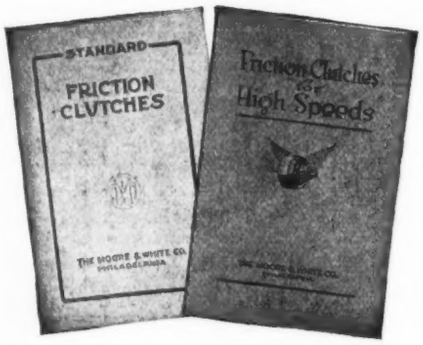
Scientifically Compounded.

For POWER PLANT Use

CLUTCH

These Books On Clutches



These books really are a necessity for the correct figuring of clutch installations. There's a lot of information in them that will save you money.

Whatever may have been your experience with clutches, you need these books. They are eye-openers.

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2703-2733 North 15th St., Philadelphia, Pa., U. S. A.
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Published in 18 sections, contains the cumulative data of 54 years' experience in the application of belting drives.
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Chas. A. Schieren Company
ESTABLISHED 1868

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Belt Manufacturers
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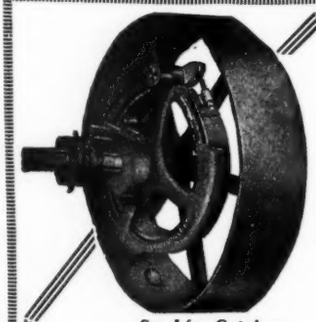
Branches and Distributors in all leading Cities



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The Caldwell Friction Clutch operates upon the simple, logical principle of harnessed friction—like your automobile brake. It consists of only eleven parts—all so designed that their greatest strength is in the direction of greatest stress. A flexible band grips the entire circumference of the friction rim and transmits full power smoothly and steadily through any change of load and speed. Ordinary clutch troubles—usually caused by one of several adjustments being too tight—are not possible in the Caldwell Clutch because one screw adjusts it; one lever controls it.

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Incorporated
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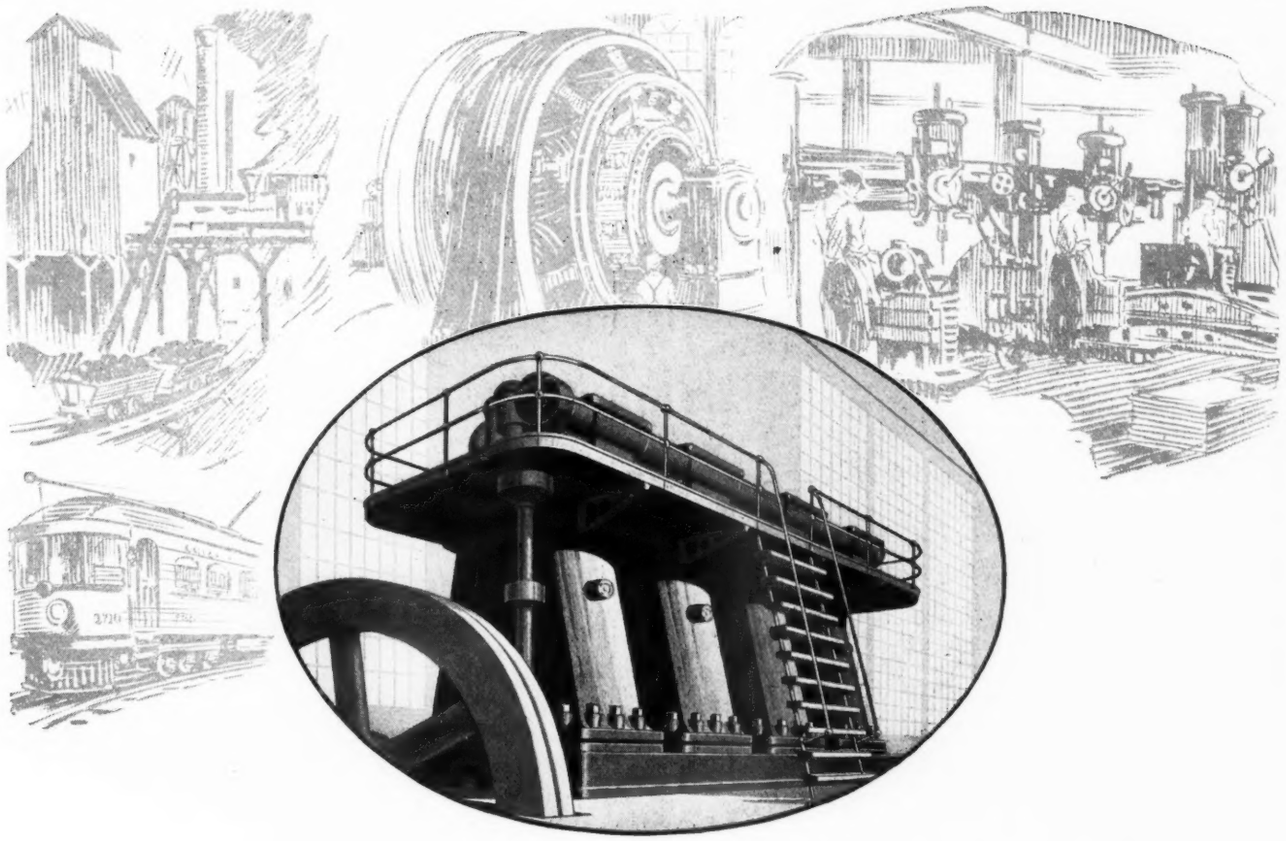

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TREMENDOUS, unpreventable losses of energy, ever present when power is produced or transmitted, make it imperative that losses which can be prevented be brought to an absolute minimum, if you are to lower your production costs.

Lubrication, with oils and greases best fitted for the work to be done, is the one method of accomplishing this. Many times it has been proven that most of this preventable loss is due to friction, caused by the use of a poor quality lubricant or the use of a good lubricant in the wrong place.

Although a Deisel engine, similar to that shown above, is one of the most efficient types of prime movers, considerable saving is possible when the proper grades of Standard lubricants are used.

When operating under ideal conditions, approximately 33% of the energy contained in the fuel you burn is effective. The balance of 67% represents heat and friction losses, both unpreventable. But if the improper grade of lubricant is used, this efficiency may easily drop as low as 25%, causing a loss of 8%, which is about one-fourth of the maximum efficiency.

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For lubricating Deisel engines, we manufacture several grades of lubricants to meet varying operating conditions. One of our competent staff of lubricating engineers will be glad to assist you in selecting the oil best suited to your work. Address our nearest Branch Office or write direct to

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Metallic Condenser Tube Packing

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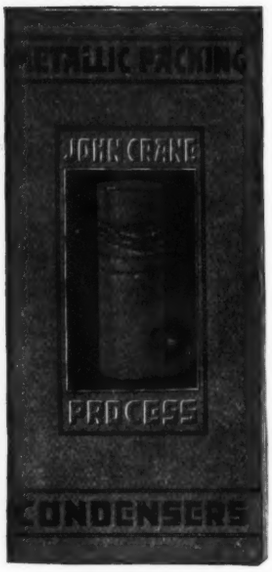
Covers causes for condenser tube deformation, disintegration, electrolytic action and remedy through use of metallic packing. Thoroughly illustrated and complete.



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"LION" Hydraulic Automatic Type

This is a natural sequence that follows the use of

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That dribbling and squirting from the stuffing boxes will cease. Slippage loss will be reduced. The rods will no longer score and wear rapidly. "Lion" Packing makes a perfect seal but never binds. It expands with the pressure and keeps the anti-friction metal studs in full contact. No leakage here. On steam rods—insist on "LION" Expanding Steam Packing. The ideal packing for difficult jobs.

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for piston rods and valve stems of stationary and marine Engines, Pumps, Compressors and Gas Engines.

Adapted for all pressures and temperatures.

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Ideal for superheated or saturated steam, ammonia, air or gas for all pressures and operating conditions. Lasts 5 to 25 years. Sold on approval.

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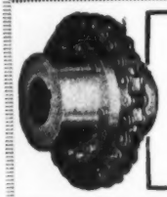
Steam, Hydraulic and Ammonia packings; Boiler Gaskets; Pump Valves.



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Flexible Couplings

eliminate misalignment trouble. Simplest construction — two forged steel sprockets and a roller chain. Put them in your drives. Write.

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The Belt Preservative-Lubricant that assures full power from slack-running belts, eliminates tension and slip, reduces friction and lubrication costs. Makes and keeps belts mellow, pliable, water-proof; preserved for longer and better service.

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Power Transmission In All Its Applications

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Ever-increasing demand for Irving Subway and Irving Safsteps has necessitated the recent addition of another unit to the Irving plant. And, in organizing and equipping this new unit, a reserve capacity has been provided adequate even to emergency demands for delivery. This is production insurance. guaranteeing to Irving customers the delivery of Subway and Safsteps on time, in any quantity needed. Let us quote upon your industrial flooring requirements. Write for Catalog 3A14.

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Manufacturers of

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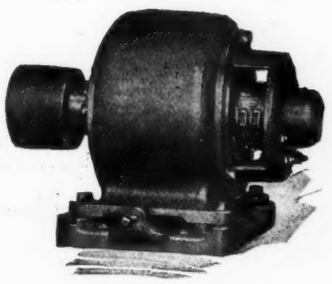
ABSOLUTELY NON-SLIPPING ALWAYS



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Form L Direct Current

MOTORS

115, 230 and 550 Volts

Motors 1/16 to 7½ Hp. Generators
0.35 to 5 K.W.

Time Tested

The C-W Form L is a small motor used in hundreds of ways and known widely for its remarkable durability and trouble proof characteristics. Often subjected to rough treatment and neglect by laymen, this motor has been remarkably successful, not because of any one special feature, but because of the careful design and construction of every detail. And this applies to all C-W machinery. It is the chief reason why Crocker-Wheeler equipment possesses its enviable reputation for reliability.

In small motor generator sets, as belted or direct connected exciters or wherever small amounts of direct current power are required, C-W Form L Generators should be specified.

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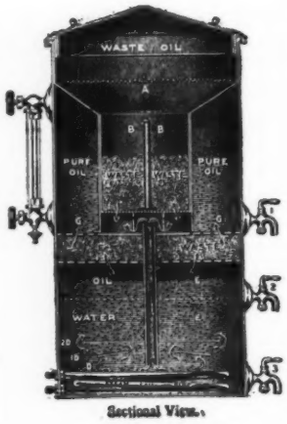
Ampere, N. J.

Users are Saving 50 to 90% on Oil Bills



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The Cross Oil Filter

This saving is by no means unusual, being brought about by reclaiming used, dirty oil with

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They remove all the dirt and foreign impurities—and deliver the oil as clean and pure as the day it left the refinery. Old oil becomes as good as new. Every bearing receives better lubrication and the all around efficiency of the plant is improved.

Thousands are in service now—giving complete satisfaction. Ask any user about the results obtained.

Sent on 30 days' trial subject to approval

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Largest Manufacturers of Oil Filters in the World
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Steam Trap Service that Precedes Installation

WE offer you the benefit of our many years experience in the design of high and low pressure systems involving the direct return of the hot condensate into the boilers.

Advise us of your conditions and our engineers will send you sketches showing location of the necessary traps and their connections which will insure complete satisfaction in operation at a decided saving in fuel.

There is no obligation for this service.

Write us for full particulars today.

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Users find it helps them to get the most from their belts. Students ask for it because it gives them the practical side of belt usage without much of the technical.
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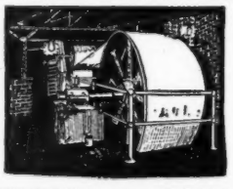

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Low first cost and very quickly installed on line shafting. The "Pinned-tight" grip does not slip.

SMITH & SERRELL, 17 Halsey Street, Newark, N. J.

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For issue of the following Tuesday

71

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Specializing in Public Utilities
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which will burn oil or tar in combination with, or without coal
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CARY, Albert A.
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Designed, Reconstructed or Tested to Produce the Most Efficient Operating Results
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and Developed for Use of All Kinds of Fuel
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Special Processes and Devices
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Inspections, Tests—Materials and Supplies
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Combustion Engineers
Fuel Oil Burning
a Specialty
Bayonne, N. J

Freyn Brassert and Company
Power Plants
Peoples Gas Building, Chicago, Ill.

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Industrial, Hydro-Electric and Steam Power Plants. Development, re-organization and valuation.
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Power Plants—Mechanical and Electrical Equipment—Heating and Ventilating
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Electric Furnace Engineering
Development, Design, Supervision
Union Bank Bldg. Pittsburgh, Pa.

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Ice Making and Refrigeration
Investigations and Reports
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An organization of Engineer Specialists
Minneapolis and Saint Paul

Public Service Production Company
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Scientific Boiler Water Purification
Coal and Ash Analysis
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STEVENS, John A.
Specialist in the Power Problems of all Industries: POWER PLANTS
Lowell — Cleveland — Fall River

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Consulting Engineers
Special designs and application of the STUMPFLOW DESIGN
in Una-Flow engines to meet any requirements. Licensors for the patents and designs of Prof. Johann Stumpf.
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POSITIONS VACANT

INSURANCE inspector wanted by one of the largest casualty insurance companies. Capable and experienced man to inspect boilers, engines, elevators and electrical machinery. Excellent opportunity for advancement to home office position for a man who first demonstrates his fitness in the field. Applicants to receive consideration should state age, education, experience (in detail) and present salary. All replies to this advertisement will be treated confidentially. P-370, Power, 10th Ave. at 36th St., New York.

Indiana

EXPERIENCED operating engineers and maintenance chief for industrial plant power station in Northern Indiana. State full particulars. P-369, Power, Old Colony Bldg., Chicago, Ill.

POSITIONS VACANT

New York

OPERATING superintendent wanted for wet process cement plant. Cement experience desirable but not essential. Technical graduate preferred. Proven ability to handle men required. Position offers excellent opportunity for permanent employment with increasing compensation. In reply give full details of experience, age, education, family, etc. P-361, Power, 10th Ave. at 36th St., New York.

Pennsylvania

COMPETENT combustion engineer wanted with college education, shop and plenty of boiler combustion experience, to supervise and make adjustments to combustion control systems. Salary to start $200 per month, location Philadelphia. Give experience and full information in answer. P-372, Power, Real Estate Trust Bldg., Phila., Pa.

POSITIONS WANTED

Michigan

SUPERINTENDENT, thoroughly experienced in manufacturing of pipe fitting, valves, cocks and plumbers' goods for water, steam, air and gas, brass, malleable and gray iron; fifteen years in charge of work in all branches of production in this line; excellent references from all former employers. PW-367, Power, Leader-News Bldg., Cleveland, Ohio.

Wisconsin

PLANT engineer, or maintenance engineer, 5 years' experience. Capable of assuming full charge of plant maintenance and power plant operation. Technical graduate. Understands combustion thoroughly. PW-371, Power, Old Colony Bldg., Chicago, Ill.

Positions Wanted ads continued on following page.

REPRESENTATIVE WANTED

(Continued from preceding page)

Representatives Calling On Power Plants
To sell a noiseless, dustless and economical pipe line ash conveyor. Above features guaranteed. Also a steam jet meeting all competition. Desirable territory including some of the largest cities now open. State qualifications. RW-354, Power, 10th Ave. at 36th St., New York.

SALESMEN WANTED

Salesmen
Territory now open: Patented air cooled refractories with a reputation made on mechanical stokers, hand stokers, hand fired, oil fuel and metallurgical furnaces. Every engineer interested. Permanent territories to live wire representatives on straight commission basis. Waite & Davey Co., Inc., 9 Jackson Avenue, Long Island City, N. Y.

Wanted—A Salesman
To sell hand stokers, shaking grates and soot cleaners, in New York and New Jersey. Perfection Grate & Supply Co., Springfield, Mass.

Live Watthour Meter Salesman Wanted
One capable correcting trouble and business builder. Willing to travel for large company in Middle West. Give reference, salary and experience. SW-358, Power, Old Colony Bldg., Chicago, Ill.

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OFFICIAL PROPOSALS

Bids: August 31.

Tenders For Plant

STATE ELECTRICITY COMMISSION OF VICTORIA
Melbourne, Australia.

Tenders are hereby invited for the supply, delivery, etc., of the following for the Morwell Power Scheme.

Copies of Tender Form and Specification will be available upon application to: Office of the Bureau of Foreign & Domestic Commerce, United States Department of Commerce, First National Bank Building, CHICAGO, and Office of the Bureau of Foreign & Domestic Commerce, United States Department of Commerce, 734 Customs House, NEW YORK CITY.

SPECIFICATION No. 23/77—ALUMINIUM STEEL CORED CABLE & ACCESSORIES

CHARGE: £2:0:0 for the first 3 copies of Tender Form, Conditions of Contract, and Specification complete. These charges will be returned on receipt of a bona-fide tender. A fourth copy and any further copies will be supplied for the sum of 10/0 each.

PRELIMINARY DEPOSIT: A preliminary deposit of £100:0:0 is to be lodged with Tender.

The Specification may be inspected at the above mentioned offices, and also at the office of: The Commissioner for Australia in U. S. A., Room 3012, 61 Broadway, NEW YORK.

The Commission does not bind itself to accept the lowest or any tender.

Tenders on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than 5 p.m., August 31st, 1923.

R. LIDDELOW, Secretary.
State Electricity Commission of Victoria,
22-32 William Street,
Melbourne,
Victoria, Australia.

GAS ENGINES

3—100-hp. Rathburn-Jones Natural or Producer Gas Engines
1—100-hp. Bruce Natural Gas Engine.
1—Forman-Bassett Gas Producer.
Also direct current generators for the above engines. All in A-1 condition and will be sold cheap.

E. T. COYLE, Columbiana, Ohio.

FOR SALE—IMMEDIATE DELIVERY

TURBINE GENERATOR UNITS

1— 250-kva. Westghse.-Parsons condensing, 3-ph., 60 cy., 2300 v., 3600 r.p.m., 150-lb. steam pressure. Complete with condenser, switchboard and instruments.

1— 500-kw., 80% P.F. (625 kva.) General Elec.-Curtis, condensing, vert., 3 ph., 60 cy., 2300 v., 1800 r.p.m., 150-lb. steam pressure. Complete with Williamson & Bros. surface condenser with auxiliaries, switchboard and instruments.

1— 600-kw., 80% P.F. (750 kva.) General Elec.-Curtis mixed pressure, condensing, 3 ph., 60 cy., 600 v., 3600 r.p.m., 165-lb. high steam pressure. Complete with C.H. Wheeler surface condenser with auxiliaries, exciter set, switchboard and instruments. (Will rewind for other voltage if desired.)

3—1000-kw., 80% P.F. (1250 kva.) General Elec.-Curtis, non-condensing, 3 ph., 60 cy., 4000 or 6600 v., 3600 r.p.m., 150 to 175-lb. steam pressure. Complete with dir. conn. exciters and motor driven rheostats.

1—1000-kw., 80% P.F. (1250 kva.) Westghse.-Parsons low p.essure, condensing, 3 ph., 60 cy., 2300 or 480 v., 3600 r.p.m., low pressure, 16 lb., high pressure, 150-lb. gauge.

1—1000-kw., 75% P.F. (1333 kva.) Westghse.-Parsons, condensing, 3 ph., 60 cy., 2300 v., 1800 r.p.m., 150-lb. steam pressure. Complete with Westghse.-LeBlanc low level jet condenser, with auxiliaries.

Wire for Prices and Option to Inspect.

THE NATIONAL POWER MACHINERY COMPANY
1915-1919 Scranton Rd., Cleveland, Ohio

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CORLISS ENGINE

400 to 500 h.p. capacity, at 125 lbs. gauge pressure. Condition must be first class. Please give specification and price, f.o.b. cars.

W-373, Power
10th Ave. at 36th St., New York City

WANTED D.C. UNIT

100 kw., 60 cy., 3 ph., 440 v., d.c. unit. Must be in good condition.

W-364, Power,
1570 Old Colony Bldg., Chicago, Ill.

TANKS

Suitable for Storage Purposes

950—Steel Tanks of every type and size from 96 gallons to 55,700 gallons. Made of plates ¼ inch to ⅝ inch thick.

for Immediate Shipment
Let us send you our Bulletin No. 7

Nashville Industrial Corporation
Jacksonville, Tennessee

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3—400 hp. B&W Vertical Header Longitudinal Drum, Boilers 150 lb. pressure, 192—4-in. Tubes, 18 ft. long, Drums, 42 in.x20 ft. 4 in., 7/16-in. thick, single lap riveted.

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1—6-in. Alberger 3-stage, Type "S" Boiler Feed Pump. 900 g.p.m., direct connected to 146 hp. Alberger-Curtis single stage non-condensing Steam Turbine.

Aluminum Ore Company
East St. Louis, Ill.

BOILER

1—380-hp. Stirling Horizontal Water Tube Boiler, 100 lb. steam pressure, 3 drums, 334 tubes, 3¾ in. dia., 3800 sq. ft. heating surface, complete with stack and accessories.

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Pittsburgh, Pa.

USED OIL ENGINES

First class condition, some practically new
20, 35, 40, 50, 65, 85, 100, 120, 140, 150, 200, 225, 280 and 500-hp., used oil engines.

GAS ENGINES
30, 125, 300, 650 hp.
Write for prices

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7 E. 42nd St., N. Y. City Tel.: Vanderbilt 9595

New Chain Grate Stokers
$5.00 H. P.

2—Stokers, 750-hp. Rating.
Immediate Southern Wisconsin Shipment

ROSS POWER EQUIPMENT CO.
Indianapolis, Ind.

Notice to Advertisers

Owing to the Holiday—Independence Day, Wednesday, July 4th—the *"Searchlight"* pages of the July 10th issue of

Power

will close for press a day earlier than usual.

Changes of Copy

and new advertisements for the July 10th issue should therefore reach us on or before 10 A. M., Tuesday, July 3rd.

Power Machinery Exchange

1 Montgomery Street, Jersey City, N.J.

A. C. DIRECT CONNECTED UNITS

3-Phase, 60-Cycle

Kva.	*Generator*	*Engine*
1200	Gen. Elec.	Filer Stowell Corliss
937	Gen. Elec.	Erie City Lentz
775	Westghse.	Hamilton, heavy duty
750	Gen. Elec.	Curtis turbine
625	Gen. Elec.	G. E. Curtiss
625	Gen. Elec.	Curtis turbine
625	Allis-Chal.	Allis-Chal. turbine
600	Gen. Elec.	Filer Stowell Corliss
500	Westghse.	Parsons turbine
500	Rdgwy.	Rdgwy., 4-valve
500	Cr.-Wheeler	Chuse Corliss
475	Gen. Elec.	Skinner Universal Uni.
430	Rdgwy.	Rdgwy., 4 V.
400	Rdgwy.	Rdgwy., single V.
375	Gen. Elec.	Ball
360	Gen. Elec.	Harris Corl.
350	Westghse.	Murray Corl.
300	Gen. Elec.	Filer Stowell
300	Gen. Elec.	Allis-Chal.
300	Allis-Chal.	Allis-Chal. turbine
300	Gen. Elec.	Hamilton Corl.
300	Allis-Chal.	Skinner
240	Gen. Elec.	Skinner Uniflow
240	Gen. Elec.	Buckeye
240	Allis-Chal.	Allis-Chal.
240	Cr.-Wh.	Buckeye
200	Allis-Chal.	Atlas, 4-valve
175	Allis-Chal.	Allis-Chal.
165	Westghse.	Erie Ball
150	Allis-Chal.	Buckeye
150	Gen. Elec.	Skinner
150	Gen. Elec.	Ames
135	Westghse.	Harrisburg, 4-valve
100	Cr.-Wh.	Harrisburg
100	Westghse.	Harrisburg, 4-valve
94	Westghse.	Parsons turbine
90	Gen. Elec.	Ames Uniflow
75	Ridgwy.	Ridgeway
70	Westghse.	Harrisburg
50	Gen. Elec.	Skinner
50	Westghse.	Erie

Uniflow Unit

240 kva. General Electric, 3 ph., 60 cy., alternator, dir. con. Skinner Universal Uniflow Engine with exciter and switchboard. Practically new, seen operating, $7,500.

TURBINE UNIT

625 kva. Gen. Elec. 3 ph., 60 cy., 480 or 240 volt with Curtis Blender type 4 stage Turbine, dir. con. exciter and condensing equipment 3 months service. Practically new, $10,000.

Motor

One 150 hp. Allis-Chalmers, 3 ph., 60 cy., 440-220 v. slip ring Motors. 400 r.p.m., with bases, pulleys and starters, $1,000, practically new.

A. C. BELTED GENERATORS

3-Phase, 60-Cycle

Kva.	*Make*	*Speed*
600 (3)	Gen. Elec.	200
550	Allis-Chal.	200
500	Allis-Chal.	600
450 (2)	Gen. Elec.	200
437 (2)	Gen. Elec.	360
400	Gen. Elec.	600
360	Westghse.	360
350	Gen. Elec.	514
312	Gen. Elec.	450
300	Gen. Elec.	720
250	Westghse.	600
200	Gen. Elec.	600
150	Gen. Elec.	720
150	Gen. Elec.	600
112 (2)	Gen. Elec.	900
100	Gen. Elec.	900
75	Gen. Elec.	900
75	Westghse.	900
50	Gen. Elec.	1200
42	Triumph	1200
30	Westghse.	1200
25	Gen. Elec.	1200

And smaller sizes.

D. C. DIRECT CONNECTED

Kw.	*Generator*	*Engine*	*Speed*
500	Wghse.	Parsons Turbine	250
300	Cr.-Wheeler	Watts-Campbell-Corliss	250
250	Ridgway	Ridgway, side crank	250
200	Allis-Chal.	Allis-Chal.-Corliss	125
200	Wghse.	Skinner	250
200	Gen. Elec.	Erie, 4-valve	250
160	Gen. Elec.	Skinner	125
150	Gen. Elec.	Curtis Turbine	125
150	Gen. Elec.	Skinner	250
120	Gen. Elec.	Harrisburg, side crank	250
100	Gen. Elec.	Erie Ball	125
100	Wghse.	Harrisburg	250
75	Gen. Elec.	Harrisburg	125
60	G.E.(3-wire)	Skinner Uniflow	250
60	Gen. Elec.	Harrisburg	125
50	Gen. Elec.	Skinner	125
40	Ridgway	Ridgway	125
35	Wghse.	Ball Wood	125
25	Wghse.	Ames	125

BIG POWER HOUSE BARGAIN for Western Nebraska Delivery

We have just purchased a complete plant at Antioch, near Alliance, Nebraska, and have an excellent steel and brick power house for sale. It can be shipped promptly and is the last word in this type of construction. The building is 50 ft. x 140 ft. x 35 ft. to eaves. It is complete with Jeffery coal handling and ash disposal system, 1734 hp., W. T. boilers—two generator sets; 10-ton crane and runway; steel ventilating sash—and will be sold at a real bargain! Complete data is on file at our office at the plant, and we can furnish reliable engineers who can adapt it to your needs, and re-erect wherever you require. If you are located in the West this is your opportunity! The building contains:

2—520-hp. Heine W.T. Boilers, with LaClede Christy grates.
2—357-hp. Heine W.T. Boilers, with LaClede Christy grates.
1—Jeffery Coal Handling and Ash Disposal System, with 270-ton Steel Coal Hopper.
2—200-kw. G. E., dir. conn. generator sets, 250 v., D.C. to Ballwood high-speed engines, self-contained, complete with switchboard, wiring, etc.
1—Whiting 47-ft. span, 10-ton overhead Traveling Crane, hand power.

In addition, at this plant there are 1400 hp. of other W. T. and H. R. T. boilers; a million feet of lumber; hundreds of pumps and tanks; 500 tons steel pipe; 50 miles wood pipe. In fact you cannot afford to overlook this opportunity if you are in need of equipment!

Write or Wire for FREE Catalog No. P. H. 5

FRANK HARRIS SONS CO., Inc., Box 1043 ALLIANCE, NEB.
(Home Office: McCormick Bldg., Chicago)

STIRLING BOILERS

823 Horse Power
Operated Less Than 90 Days

30—Class M-30 823 H.P. Babcock and Wilcox Stirling Water Tube Boilers, 200 lbs. pressure. Drums double riveted, double strap butt joint. Complete with Westinghouse Stokers, Forced Draft Fans, Vulcan Soot Blowers and all accessories. Inspection invited.

Send for Our Special Specifications Folder.

Nashville Industrial Corporation
Jacksonville, Tennessee

USED MOTORS FOR SALE

100 used D.C. Crocker-Wheeler 40-degree, 220-volt Motors. All sizes ¼ to 35 hp., in good operating condition; only slightly used.

E. J. BRACH & SONS
4600 W. Kinzie St., Chicago
Telephone: Mansfield 1200

FOR SALE

ENGINES

1—Hamilton Corliss Engine in A-1 condition. Price..... $750.00
1—150-hp. Miami Gas Engine, practically new. Price..... 675.00

MIAMI POWER COMPANY, Franklin, Ohio

A BOILER BARGAIN

3—60-in. x 18-ft., 125-lb. Boilers, with breeching and stack.
1—Stillwell Open Heater.
1—Worthington Duplex Feed Pump.

Immediate delivery in whole or in part.

BUCKMASTER-LUCK-MALOCHEE, INC.
New Orleans, La.

MOTOR GENERATOR SET

General Electric Type KT, 85 hp., 3 ph., 60 cy., 440 v. or 220-v. Motor, 40 deg., 900 r.p.m. Northern Generator, compd. wound, 60 kw., 250 v., Compensator and Field Rheostat. Mounted Timber Base. Insulated Coupling.
Used Short Time as Spare

GARY SCREW & BOLT COMPANY
Gary, Indiana.

GENERATORS Linder Machinery Co.

50 Church Street, N. Y. C.

A. C. DIRECT CONNECTED UNITS

3-Phase, 60-Cycle

Kva.	*Generator*	*Engine*
1500	Allis-Chalmers	Kerr Turbine
1200	General Electric	Flier & Stowell
1000	Westinghouse	Parsons Turbine
600	Allis-Chalmers	Green Wheelock
500	Ridgway	Ridgway, 4-valve
400	Ridgway	Ridgway
300	General Electric	Curtis Turbine
250	Western Electric	Fulton Iron Works
240	Crocker-Wheeler	Buckeye
200	Ridgway	Ridgway, 4-valve
200	Allis-Chalmers	Atlas, 4-valve
170	General Electric	Harris-Corliss
125	General Electric	Erie City
100	Allis-Chalmers	American Ball
100	Western Electric	Erie City, 4-valve
100	Westinghouse	Skinner
75	General Electric	American Ball
75	Westinghouse	Erie City

75 K.W. SPRAGUE

250 Volt E 80 R.P.M.

d. c. to Harrisburg Engine Complete

$800 F.O.B. NEW YORK

100 K.W. GEN. ELEC.

125 Volt 250 R.P.M.

d. c. to Ames Engine Complete

$1000 F.O.B. NEW YORK

A. C. BELTED GENERATORS

3-Phase, 60-Cycle

Kva.	*Generator*
300	Westinghouse
150	Triumph
100	General Electric
100	General Electric
42	Triumph

D. C. DIRECT CONNECTED

Kw.	*Generator*	*Engine*
500	Crocker-Wheeler	Terry turbine
300	General Electric	Curtis turbine
200	General Electric	Cooper-Corliss
200	Sprague	Harrisburg
150	Westinghouse	Harrisburg
150	Crocker-Wheeler	De La Vergne Turbine
125	Crocker-Wheeler	Hewes & Phillips Corliss
100	General Electric	Ball & Wood
75	General Electric	Ames
60	General Electric	American Ball

---

300 K. W.

ENGINE-GENERATOR

SPECIAL BARGAIN

1—300 kw., 2300 v., 3 ph., 60 cy., Fort Wayne Alternator direct connected to Russell 22-in.x24-in. four-valve horizontal engine.

Cheap Before Removal

THE O'BRIEN MACHINERY CO.

113 N. Third St., Philadelphia, Pa.
Long Distance Bell Phone: Market 0727
Cable Address: OBRIEN, Philadelphia.

BOILER EQUIPMENT

3—New 408-hp. Heine, 180 lb., with stkr.
4—New 1150-hp., 250 lb.
3—New 290-hp. B. & W., 200 lb.
4—NEW Bayer Soot Blowers for 490-hp. boilers.
300-hp. B.&W. Buttstrapped, 150-lb. Iowa.
2—276-hp. Stirling, 150-lb. Illinois.
2—307-hp. Stirling, shaking gr. Mo.
1—400-hp. Vogt, 150 lb., with Jones Stkr. Ky.
2—400-hp. Edgemore, 200-lb. Ind.
6—420-hp. B.&W. type, 150-lb. Iowa.
2—480-hp., 160-lb. Stirling. Va.
500-hp. Rust type, B.&K., 180-lb. Ohio.
3—500-hp. class F-29, Stirling, 150-lb. Pa.
505-hp. Stirling, 160-lb. Ind.

Send for our new list of Power Plant Equip.

ROSS POWER EQUIPMENT CO.
Indianapolis, Ind.

Stokers and Engines

4 Stokers, Westinghouse.

7 Retort and 2 Westinghouse Engines, 2 stokers and 1 engine used only short time, the other pair never used.

West Virginia Pulp & Paper Co.
200 Fifth Ave., New York, N. Y.

Engine and Boilers

1 George H. Corliss 200 hp. Engine.

3 H. R. T. 100 hp. Boilers, 100 lb. pressure.

1 H. R. T. 100 hp. Boiler, 125 lb. pressure.

Can be seen in use here. Will be removed soon to make room for those of larger capacity.

The David Maydole Hammer Co.
Norwich, N. Y.

CORLISS ENGINES

18 x 36 Heavy Duty Design
New and Like New

Specifications and drawings sent upon request to Owner.

Roy Brenholts, Trustee
44 E. Broad St., Columbus, O.

FOR SALE

Corliss Steam Engine

50-hp. Murray, with fittings in excellent condition. Very cheap.
Also 18-ft. 3-15/16 steel shaft with 4-ring oiler Hangers.

J. P. MATHIEU, INC.,
220 E. Collom St., Germantown, Phila., Pa.

BOILER

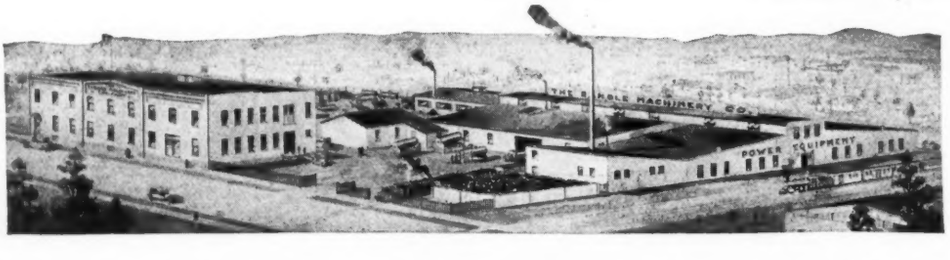
—250 Hp. Return Tubular 84 in. x 18 ft.

BENTLEY-MORRISON CORP.
Elizabeth, N. J.

POWER PLANT MACHINERY

Engines **Pumps** **Motors** **Motor Generators**
Boilers **Heaters** **Generators** **Turbo-Generators**

Rebuilders of Machinery For 37 Years



Rebuilders of Machinery For 37 Years

THE RANDLE MACHINERY CO., 1768 Power St., (Cumminsville) CINCINNATI, O.

HIGH-GRADE USED BOILERS

At Very Attractive Prices

Wide Range of Sizes, Types and Pressures

PARTIAL LIST

No.	*H.P.*	*Make*	*Location*
2	813	Edge Moor	Hopewell, Va.
9	600	Edge Moor	Hopewell, Va.
2	550	Edge Moor	Carney's Pt., N. J.
3	512	Stirling Class S No. 26	Carney's Pt., N. J.
1	440	Edge Moor	West DePere, Wis.
1	400	Stirling	Vincennes, Ind.
2	400	Wickes	Hammond, Ind.
1	400	B. & W.	Bay City, Mich.
2	389	Heine	Springfield, O.
3	389	Heine	West DePere, Wis.
2	350	B. & W.	Boston, Mass.
4	350	Stirling	Boston, Mass.
1	320	B. & W.	Philadelphia, Pa.
1	300	Wickes	West DePere, Wis.
1	300	Edge Moor	West DePere, Wis.
2	267	B. & W.	Repauno, N. J.
2	253	Stirling Class E No. 22	Haskell, N. J.

No.	*H.P.*	*Make*	*Location*
1	250	Wickes	Hammond, Ind.
1	250	Wickes	Hammond, Ind.
1	250	B. & W.	Joliet, Ill.
2	238	Edge Moor	Carney's Pt., N. J.
1	234	Edge Moor	Carney's Pt., N. J.
1	225	Geary	Chicago, Ill.
2	210	B. & W.	Joliet, Ill.
1	200	Scotch Marine	Whippany, N. J.
1	199	Edge Moor	Carney's Pt., N. J.
3—72 in. x 20 ft.	175	H. R. T.	Williamsport, Pa.
1—72 in. x 18 ft.	150	H. R. T.	Dodge City, Kan.
5—72 in. x 18 ft.	150	H. R. T.	West DePere, Wis.
1—72 in. x 18 ft.	150	H. R. T.	West DePere, Wis
1—72 in. x 16 ft.	125	H. R. T.	Dodge City, Kan.
1—66 in. x 16 ft.	100	H. R. T.	Dodge City, Kan.
1	100	Smith H. R. T.	Carney's Pt., N. J.
2—66 in. x 16 ft.	100	H. R. T.	Chicago, Ill.

Write us about your requirements, we can probably fill your order from stock not listed above.

J. F. DAVIS & SONS COMPANY

1122-1123-1124 Harris Trust Bldg., Chicago, Ill.

We are also manufacturers of High Pressure Steam Boilers

FOR SALE

Old Ben Equipment Released by Change to Electric Power

Standard makes, good condition for all mining purposes.

Send for complete illustrated descriptive Catalog.

This Is a Real Bargain Opportunity

Old Ben Coal Corporation
P. W. Beda, V. P.
1845 Illinois Merchants Bank Bldg., Chicago, Ill.

BOILERS

12 Geary and 6 Bonus Freeman. 370 hp., complete with Combustion Engineering Co.'s Type E Stokers. Installed 1902 to 1911 and used continuously since at 200 lb. pressure. Also one 200 hp. B. & W. 125-lb. Boiler installed in 1906 and 1 steel stack, 8 ft.x150 ft., nearly new. Price and complete data on application.

WEST PENN POWER CO.
P. O. Box 1223, Pittsburgh, Pa.

CENTRIFUGAL PUMPS

NEW AND USED

10—2½ in. American Type A, Belt Driven
25—4 in. Baker Belt Driven
75—5 in. Gould Belt Driven
24—6 in. Baker Belt Driven
2—10 in. Allis-Chalmers Type S, Direct connected to Motor
6—14 in. Worthington Class B, Direct connected to Motor
4—14 in. Allis-Chalmers Type S, Direct connected to Turbine
6—16 in. Allis-Chalmers Type S, Direct connected to Turbine

Let us submit our quotations.

Nashville Industrial Corporation
Jacksonville, Tennessee

NEW PUMPS

Immediate Shipment

8-in. Worthington Volute, 3000, c.p.m., 170-ft. head; also 10-in. pump, 3000 g.p.m. at 115-ft. or 170-ft. head, both driven by G. E. turbines for 125-150 lb. steam. Also 6-in., 4-stage Allis-Chalmers, 1000 g.p.m., 635-ft. head, 1760 r.p.m. with or without A.C. motor or can be arranged for turbine drive.

ROY BRENHOLTS, Trustee.
44 E. Broad St., Columbus, Ohio

FOR SALE

Green-Corliss Engine

1—Right hand, 18 in. x 42 in., flywheel 14 ft. x 32 in.

Can Be Seen in Operation.
Delivery July or August.

GEO. C. HETZEL CO., Chester, Pa.

A

"Searchlight"

Ad

Costs Little

and is

Quick Acting

0231

FOR SALE

300 K. V. Synchronous Motor or Generator

Allis-Chalmers, 2 ph., 60 cy., 250 v., 150 r.p.m., two-bearing machine. Excellent condition. Ideal for direct connection to engine or for P.F. correction. No additional equipment. Price f.o.b. cars $2,500.

FS-368, Power
10th Ave. at 36th St., New York City.

FOR SALE

300 kw., 3 Wire, 125/250 Volts

CROCKER-WHEELER GENERATOR

Direct Connected to

ALLIS-CHALMERS CORLISS ENGINE

Heavy Duty Condensing — **Cross Compound 150 r.p.m.**

MARVIN BRIGGS, INC.
167 Sixth St., Brooklyn, N. Y.

THE NEW WAY

This Station uses Larry Cars, feeding a Modern Skip Hoist, Which Discharges to an

ASH

100 TON CAST IRON BUNKER,

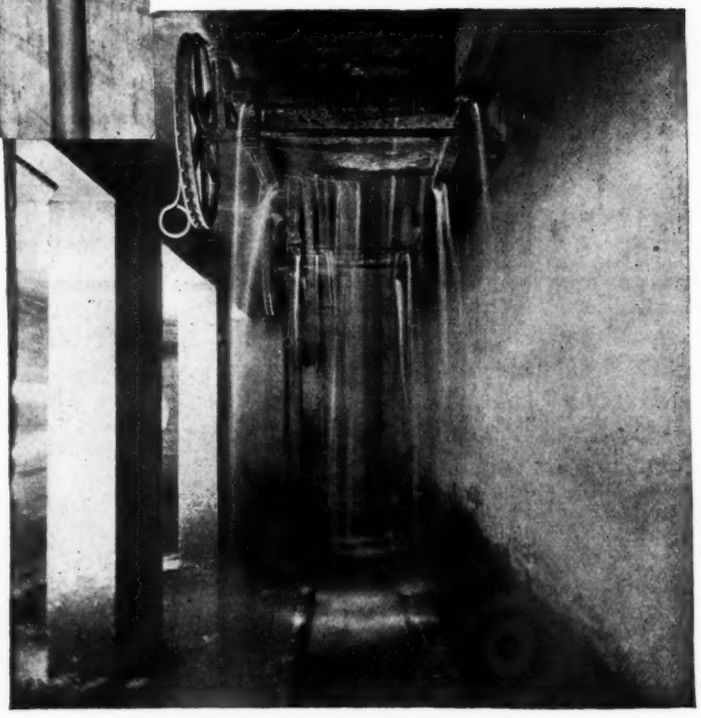
Located Over Railroad Tracks. The total cost of Ash Handling From Stoker Hopper to Railroad Cars is Less Than 10 Cents per Ton.

In December 1921 This Large Central Station Bought 12 Power Operated

← ASH

GATES Water Collecting

Today, These People Have 28 Such Gates in Service Representing 2 Repeat Orders



THE OLD WAY

(Abandoned)

ASH **The Allen-Sherman-Hoff Co.** ASH

Philadelphia, Pa.

CAST IRON FOR RESISTING ACID & HEAT — SHOP ASSEMBLED — ASH MACHINES — SHOP TESTED — STEEL FOR STRENGTH AND ALIGNMENT

200,000 Boiler Horsepower
in service and under construction

Why?

Because we have designed an

ASH Hopper and Gate

that is standardized in modern stations.

Features which we have originated and which are now in standard modern practice are—accurately machined, shop aligned, shop tested and self-contained.

ASH Gates

ASH Gates That Collect 100% of the Quenching Water

introduced into the hopper.

Quenchers—an accessible device, which cools the ashes in the hopper with a fraction of the water used with the old system.

A cast iron hopper with a fire brick lining, which lining is supported independently of its own strength.

Other important details are too numerous to mention.

Write us for Bulletin "P"

The Allen-Sherman-Hoff Co.
Philadelphia, Pa.

WHAT AND WHERE TO BUY

Equipment, Apparatus and Supplies Used in the Power Plant Field with Names of Manufacturers and Distributors

Please refer to the Buying Section for addresses of concerns listed in this directory.
See Last Page for Alphabetical Index

Aftercoolers and Receivers, Air
Chicago Pneumatic Tool Co.

Air Chambers
Hercules Float Works

Air Conditioning
Buffalo Steam Pump Co.

Alarms, Low Water
Elliott Co.
Lunkenheimer Co.
Reliance Gauge Column Co.
Wright-Austin Co.

Alternators
Allis-Chalmers Mfg. Co.

Alternators, Turbo
Allis-Chalmers Mfg. Co.
General Electric Co.
Kerr Turbine Co.
Ridgway Dyn. & Eng. Co.
Terry Steam Turbine Co.

Arches, Suspended
Bigelow Arch Co.
Detrick Co., M. H.
Illinois Stoker Co.
Jointless Fire Brick Co.
Liptak Fire Brick Arch Co.
McLeod & Henry Co.

Ash Handling Machinery
(See Coal and Ash Handling Machinery)

Ash Tanks, Steel
Allen-Sherman-Hoff Co.
Heine Boiler Co.

Baffle Walls
Johns-Manville, Inc.
McLeod & Henry Co.
Power Plant Efficiency Co.

Baffles, Boiler
Betson Plastic Fire Brick Co.
Engineer Co.
Harbison-Walker Refractories Co.
Johns-Manville, Inc.
Jointless Fire Brick Co.
King Refractories Co.
Power Plant Efficiency Co.

Baffles, Monolithic
Betson Plastic Fire Brick Co.
King Refractories Co.

Bearings
Hoyt Metal Co.
Magnolia Metal Co.

Belting
Garlock Packing Co.
Greene, Tweed & Co.
Quaker City Rubber Co.
Rhoads & Sons, J. E.
Schieren Co., Chas. A.

Belting Conveyor
Jeffrey Mfg. Co.

Belting Leather (Waterproof)
Rhoads & Son, J. E.
Schieren Co., Chas. A.

Belting, Link Leather
Schieren Co., Chas. A.

Belting, Rubber
Quaker City Rubber Co.

Bins
Allen-Sherman-Hoff Co.
Blaw-Knox Co.
Brown Hoisting Machy. Co.

Blowers, Centrifugal
Coppus Eng. Corp.
Carling Turbine Blower Co.
Green Fuel Economizer Co.
Jeffrey Mfg. Co.
Kerr Turbine Co.
Terry Steam Turbine Co.
Wing Mfg. Co., L. J.

Blowers, Fan
American Blower Co.
Buffalo Steam Pump Co.
Clarage Fan Co.
Coppus Eng Corp.
De Laval Steam Turbine Co.
Engineer Co.
General Electric Co.
Green Fuel Economizer Co.
Jeffrey Mfg. Co.
Power Turbo-Blower Co.
Sturtevant Co., B. F.
Terry Steam Turbine Co.
Wing Mfg. Co., L. J.

Blowers, Forced Draft
American Blower Co.
Buffalo Steam Pump Co.
Carling Turbine Blower Co.
Clarage Fan Co.
Coppus Eng Corp.
Jeffrey Mfg. Co.
Wing Mfg. Co., L. J.

Blowers, Induced Draft
Clarage Fan Co.
Coppus Eng Corp.
Jeffrey Mfg. Co.

Blowers, Steam Jet
Chesterton Co., A. W.
McClave-Brooks Co
Schutte & Koerting Co.

Blowers, Turbine
Carling Turbine Blower Co.
Coppus Eng Corp.
Ingersoll-Rand Co.
Kerr Turbine Co.
Moore Steam Turbine Corp.
Power Turbo-Blower Co.
Sturtevant Co., B. F.
Terry Steam Turbine Co.
Wing Mfg. Co., L. J.

Boiler Insulation
Celite Products Co.
Johns-Manville, Inc.
Keasbey & Mattison Co.

Boiler Setting
Ballard, Sprague & Co.
Betson Plastic Fire Brick Co.
Boiler-Kote Co.
Cokal Stoker Corp.
Continental Chimney Co.
Detrick Co., M. H.
Illinois Stoker Co.
Jointless Fire Brick Co.
Liptak Fire-Brick Arch Co.
McLeod & Henry Co.
Naismith & Son, Geo.
Queen's Run Refractories Co.
Waite & Davey Co.

Boiler Tube Cap Reseating Machine
Lagonda Mfg. Co.

Boiler Tube Cleaners
(See Tube Cleaners, Boiler)
(See Soot Blowers)

Boiler Tubes
Boiler Tube Co. of Am.
Pittsburgh Steel Products Co.

Boilers, Heating
Oil City Boiler Works

Boilers, Portable
Erie City Iron Works
Page Boiler Co.

Boilers, Return Tubular
Ames Iron Works
Bigelow Co.
Cokal Stoker Corp.
Connery & Co.
Delany & Co., P.
Erie City Iron Wks.
Newburg Steam Boiler Works
Smith & Sons Co., Samuel
Union Iron Works
Vogt Machine Co., Henry
Walsh & Weidner Boiler Co.

Boilers, Vertical Water Tube
Babcock & Wilcox Co.
Bigelow Co.
Casey-Hedges Co.
Erie City Iron Wks.
O'Brien Boiler Wks. Co., J.
Wickes Boiler Co.

Boilers, Water Tube
Abendroth & Root Mfg. Co.
Babcock & Wilcox Co.
Badenhausen, Phillips
Bethlehem Shipbuilding Corp.
Bigelow Co.
Brunswick-Kroeschell Co.
Casey-Hedges Co.
Connelly Boiler Co., D.
Erie City Iron Works
Heine Boiler Co.
Ladd Co., Geo. T.
Lasker Iron Wks.
O'Brien Boiler Wks. Co., J.
Oil City Boiler Works
Page Boiler Co.
Springfield Boiler Co.
Union Iron Works
Vogt Machine Co., Henry
Walsh & Weidner Boiler Co.
Wickes Boiler Co.

Books
McGraw-Hill Book Co.
Wiley & Son, John

Breechings
Connery & Co.
Littleford Bros.
Smith & Sons Co., Samuel

Brick, Fire
Betson Plastic Fire Brick Co.
Boiler-Kote Co.
Green Fire Brick Co., A. P.
Harbison-Walker Refractories Co.
King Refractories Co.
McLeod & Henry Co.
Queen's Run Refractories Co.
Waite & Davey Co.

Brick, Insulating
Celite Products Co.

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Combustion Eng. Corp.
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Lockett & Co., A. M.
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Schutte & Koerting Co.

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Builders Iron Foundry
McClave-Brooks Co.
Neemes Bros.

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Fuller-Lehigh Co.
Harrisburg Fdry. & Mach Works
Pyramid Iron Products Corp.

Cement, Asbestos
Keasbey & Mattison Co.

Cement, Iron
Smooth-On Mfg. Co.

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Boiler-Kote Co.
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Smooth-On Mfg. Co.

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Cocks, Gage
Jenkins Bros.

Cocks, Steam
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Merrill Co.
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Cokal Stoker Corp.
Detrick Co., M. H.
Green Fire Brick Co., A. P.
Jointless Fire Brick Co.
McLeod & Henry Co.

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Hays Corp., Jos. W.
Republic Flow Meters Co.
Yarnall-Waring Co.

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Bury Compressor Co.
Gardner Governor Co.
General Electric Co.
Ingersoll-Rand Co.
Nordberg Mfg. Co.
Pennsylvania Pump & Compressor Co.
Sullivan Machinery Co.
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Sullivan Machinery Co.

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Elliott Co.
Griscom-Russell Co.
Ingersoll-Rand Co.
Schutte & Koerting Co.
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Wheeler Mfg. Co., C. H.
Wheeler Cond'r & Eng. Co.
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Ingersoll-Rand Co.

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Bethlehem Shipbuilding Corp
Ross Heater & Mfg. Co.

Condensers, Jet
Elliott Co.
Ingersoll-Rand Co.
Schutte & Koerting Co.
Wheeler Mfg. Co., C. H.

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Smith & Serrell

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Celite Products Co.
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Ric-Wil Co.

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Orton & Steinbrenner Co.

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McMyler Interstate Co.

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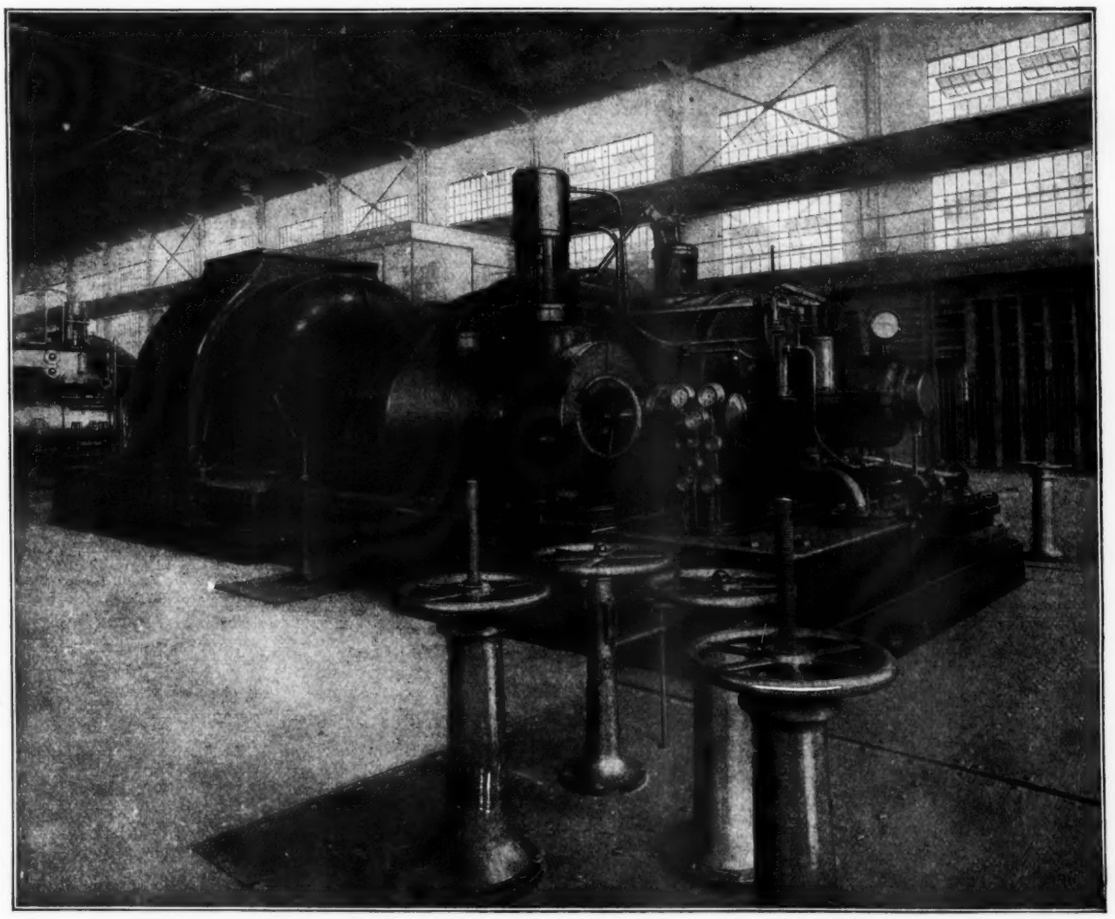

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Sullivan Machinery Co.

Hoists, Steam
Sullivan Machinery Co.

Hoppers, Coal and Ash
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Beaumont Co., R. H.
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Jeffrey Mfg. Co.
Link-Belt Co.

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Chicago Pneumatic Tool Co.
Lagonda Mfg. Co.

Hose, Boiler Cleaning
Lagonda Mfg. Co.

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Quaker City Rubber Co.

Hose, Steam
Elliott Co.

Hose, Water
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Lunkenheimer Co.
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Smith & Serrell

Ladder Treads, Non-Slipping
Irving Iron Works

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General Electric Co.

Lamps, Incandescent
General Electric Co.

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Keystone Lubricating Co.
Standard Oil Co. of Ind.

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Greene, Tweed & Co.
Keystone Lubricating Co.
Ohio Grease Co.

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Penberthy Injector Co.
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Republic Flow Meters Co.

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Bailey Meter Co.

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Builders Iron Foundry
General Electric Co.
Republic Flow Meters Co.

Meters, Oil
Builders Iron Foundry
General Electric Co.
Republic Flow Meters Co.

Meters, Steam
Bailey Meter Co.
Builders Iron Foundry
General Electric Co.
Republic Flow Meters Co.

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Bailey Meter Co.
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Meters, Water
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Elliott Co.
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Goetze Gasket & Pkg. Co.
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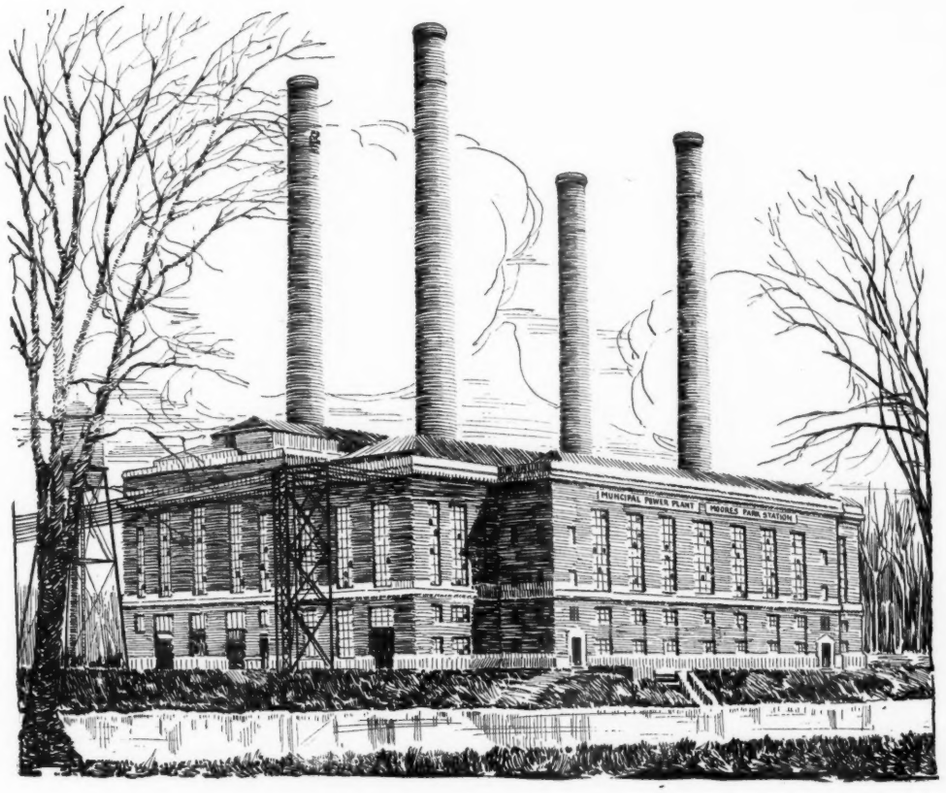

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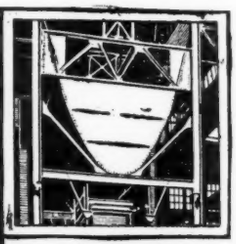

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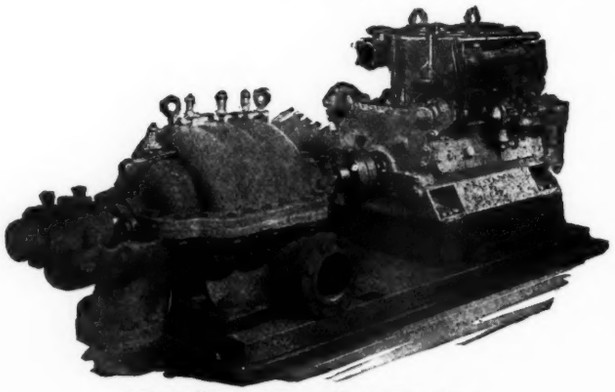

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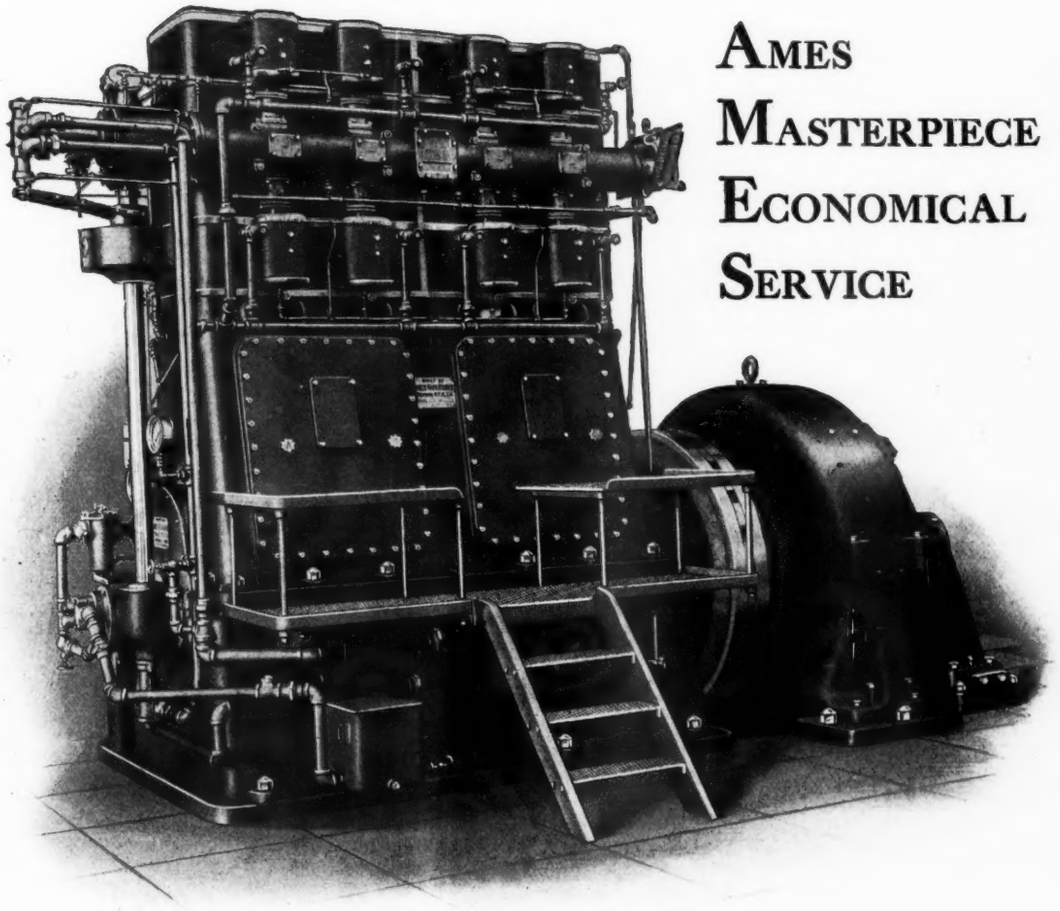

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